Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
Delete, Delete, Delete	)	
Implementing Executive Order 14192	)	GN Docket No. 25-133
Of January 31.2025	)	

Comments of Environmental Health Sciences

The Environmental Health Sciences, a scientific non profit organization dedicated to driving high quality science into public health policies, submits the following comments in response to the FCC's opening of a public docket in which the agency seeks comment on every rule, regulation, or guidance document that the agency should modernize and or eliminate for the purposes of alleviating unnecessary regulatory burdens.

Introduction

1.The FCC must modernise wireless radiation safety limits to be science based.
2. The FCC must modernize FCC RF limits and regulations so that wildlife, trees, plants and the environment are protected.
3. The FCC must require independent premarket safety testing of wireless technologies.
4. The FCC must ensure adequate post market surveillance regarding RF compliance for devices as well as cell towers.
5. The FCC must modernize RF compliance test procedures to reflect today's consumers and the RF exposed (from babies to the medically vulnerable) as well as the real-world use patterns of cell phones and wireless devices.
6. The FCC must pause further 5G and new wireless technology expansion until independent research verifies safety.
7. The FCC must reinstate local authority over cell towers and 5G/4G "small cell and wireless facility infrastructure deployment.
8. The FCC must address regulatory capture at the agency and the undue influence of the wireless industry.
9. FCC must ensure consumers are informed about the Wireless radiation and fine print warnings.
10. Cost-benefit considerations support modernizing wireless radiation limits

Appendix

Appendix 1: Substantial scientific research indicates serious human health impacts from continued wireless proliferation.
Appendix 2: Substantial scientific research indicates serious wildlife and environmental impacts of unfettered wireless proliferation
Appendix 3: Substantial scientific research has found these effects well below current FCC limits.

Introduction

Current FCC human exposure limits for wireless radiation, unchanged since 1996, are non-protective. substantial scientific research indicates serious human health impacts from continued wireless proliferation. Beyond human health, wireless radiation is also linked to adverse effects on wildlife—especially pollinators like bees and insects. Adverse effects are documented well below the limits of the FCC (as well as the IEEE and ICNIRP).

To safeguard public health, particularly among vulnerable populations, and protect wildlife, the FCC should modernize RF exposure standards based on current science, require independent safety testing of wireless technologies, reinstate local authority over 5G infrastructure deployment, and pause further expansion until independent research verifies safety.

Further, due to the FCCs own documented reports of wireless radiation exposures from cell phones that exceed FCC limits, the FCC must also modernize its compliance test procedures to reflect today's real world use of cell phones and wireless devices. As cell towers and 5G wireless antenna facilities also are documented to exceed limits, the FCC must also implement a robust post market compliance program with enforcement measures network infrastructure including cell towers, small cells and base station network antennas.

In the Request for Comment, the FCC asked if existing rules could give rise to a risk of regulatory capture?” and the answer is “yes” as documented in this comment.

1.The FCC must modernise wireless radiation safety limits to be science based.

The FCC needs to update its wireless radiofrequency (RF) radiation human exposure limits because current limits are inadequate to protect human health and the environment.

The FCC’s human exposure limits were set in 1996. Since that time, there has been no scientific review of these limits to ensure they are based on up-to-date science. Nor has any federal

agency with health or environmental expertise performed a robust health risk assessment on wireless radiation based on the totality of available scientific evidence.

FCC has not complied with a federal court order to explain how its 1996 wireless radiation limits are adequately protective. In 2021, the U.S. Court of Appeals, DC Circuit ruled that the FCC's decision that its 1996 limits did not need an update was "arbitrary and capricious," not evidence-based, and in violation of the Administrative Procedures Act because the FCC did not show adequate review of non-cancer evidence. The Court highlighted the "silence" of expert agencies (i.e the EPA, CDC, and NIH), none of which provided any science-based reports on how FCC limits compare to the scientific evidence.

The DC Circuit judgement mandated the FCC to provide a reasoned explanation for how its limits were adequately protective on the following issues:

- Children's health
- Long-term exposure
- Impacts to the environment
- Cell phone and wireless device compliance test procedures
- The ubiquity of wireless devices, and other technological developments since 1996.

The FCC has not responded to the court mandate. Thus, the FCC's 1996 limits can't be said to rest on an up-to-date review.

As background, the U.S. Government Accountability Office issued a 2012 report recommending the FCC formally reassess its 1996 RF exposure limits to ensure the limits reflect the latest research. In response, the FCC opened up an inquiry, Docket 13-84 (2013) requesting comments on the adequacy of its RF human exposure limits, specifically in regards to children and cell phone test procedures. Despite over a thousand submissions, including hundreds of published studies showing harmful impacts, in 2019, the FCC decided that its 1996 human exposure limits didn't need to be updated with little explanation, leading to the legal case.

The FCC's wireless limits were not designed to protect against cancer or impacts to the neurological, reproductive, cardiac or endocrine systems.

The limits were developed three decades ago based on the assumption that wireless RF (AKA microwaves) could only lead to harmful health effects through the overheating of tissue. This is why U.S. FCC limits are called "thermal" limits. U.S. Naval research from the early 80's had found behavioral disruption in rats and small monkeys heated by exposure to microwaves for under an hour. The behavioral changes were linked to an increased temperature of 1.0 °C , with whole body 4 W/kg as the threshold dose for harmful effects. The FCC, IEEE and ICNIRP limits are all based on this determination that 4 W/kg is the level of harm, as this level increases the temperature in tissues.

Notably, the EPAs last report on EMF biological effects was in 1984 and found biological impacts starting around 1W/kg. There had long been numerous reports of a range of

non-heating biological impacts (especially neurological and endocrine effects), but they were not considered “established.”

As the EPA stated,“The FCC exposure guideline is considered protective of effects arising from a thermal mechanism but not from all possible mechanisms. Therefore the generalization by many that the guidelines protect human beings from harm by any or all mechanisms is not justified.”

The majority of studies have found effects from wireless RF. Dr. Henry Lai found the majority of research studies found impacts.

> Dr. Henry Lai Summary of Results (Last partial update: March 11, 2025) Link.
>
> Radio frequency radiation (RFR)
>
> 89% (n=350) of 393 RFR oxidative effects (or free radical) studies published since 1997 reported significant effects including 96% (n=97) of 101 studies with a SAR (specific absorption rate) ≤ 0.40 watts per kilogram (which is ten times less than the 4.0 W/kg threshold of harm that the FCC and the ICNIRP use to base their RFR exposure limits).
>
> 71% (n=348) of 490 RFR genetic effects studies published since 1990 reported significant effects including 79% (n=122) of 155 studies of gene expression.
>
> 77% (n=352) of 455 RFR neurological studies published since 2007 reported significant effects.
>
> 84% (n=303) of 358 RFR reproduction and development studies published since 1990 reported significant effects. Among the low-intensity exposure studies that reported significant effects, 59 studies used an exposure with a SAR ≤ 0.40 W/kg and 41 studies had a SAR ≤ 0.08 W/kg.
>
> 95% (n=225) of 237 RFR low-intensity exposure studies (SAR < 0.40 W/kg) published since 1990 reported significant effects.
> https://www.saferemr.com/2018/02/effects-of-exposure-to-electromagnetic.html

A review of low intensity studies found that biological effects could occur at a median specific absorption rate (SAR) of 0.0165 W/kg (Lai and Levitt 2022), much lower than the FCC’s limits of 1.6 W/kg (cell phone and wireless device local tissue limit) and 0.08 W/kg (averaged whole body limit). Further, FCC limits are often stated to have a 50 times safety factor, which the current scientific evidence does not support.

In 2018 the NTPs final report on their completed studies concluded DNA damage and “clear evidence” of an association with two types of cancer in male rats: schwannomas of the heart

and gliomas of the brain. These findings were corroborated by large scale animal studies of the Ramazzini Institute which found the same tumor types, but at much lower exposure levels, as the study was intended to mimic cell tower-level radiation.

Numerous studies[1] on a wide variety of endpoints have found impacts from longer-term exposures, as well as impacts to generations post-exposure[2].

The induction of oxidative stress which, with repeated exposure, could then contribute to health conditions is considered one of the key factors in how low-level chronic EMF exposure can lead to health effects (Georgiou & Margaritis 2021, Lai, & Levitt, 2023, Panagopoulos et al, 2021, Schuermann & Mevissen, 2021).

For more documentation, see substantial supporting scientific evidence in Appendix 1: Substantial scientific research indicates serious human health impacts from continued wireless proliferation and Appendix 3: Substantial scientific research has found effects well below current FCC limits for more documentation.

[1] Miller, A. B., Sears, M. E., Morgan, L. L., Davis, D. L., Hardell, L., Oremus, M., & Soskolne, C. L. (2019). Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices. Frontiers in Public Health, 7; Davis, D., Birnbaum, L., Ben-Ishai, P., Taylor, H., Sears, M., Butler, T., & Scarato, T. (2023). Wireless technologies, non-ionizing electromagnetic fields and children: Identifying and reducing health risks. Current Problems in Pediatric and Adolescent Health Care, 53(2), 101374.

[2] Cantürk Tan, F., Yalçin, B., Yay, A. H., Tan, B., Yeğin, K., & Daşdağ, S. (2022). Effects of pre and postnatal 2450 MHz continuous wave (CW) radiofrequency radiation on thymus: Four generation exposure. *Electromagnetic Biology and Medicine*, *41*(3), 315–324; Tan B, Canturk Tan F, Yalcin B, Dasdag S, Yegin K, Yay AH. (2022) Changes in the histopathology and in the proteins related to the MAPK pathway in the brains of rats exposed to pre and postnatal radiofrequency radiation over four generations [published online ahead of print, 2022 Oct 29]. J Chem Neuroanat.126:102187

2. The FCC must modernize FCC RF limits and regulations so that wildlife, trees, plants and the environment are protected.

Despite rising environmental levels of wireless radiation, exposure limits designed to ensure protections for birds, bees, trees and wildlife do not exist. This is a critical regulatory gap.They must be protected with federally developed science based limits.

In 2021, the DC Circuit stated that the FCC had “completely failed even to acknowledge, let alone respond to, comments concerning the impact of RF radiation on the environment,” highlighting a U.S. Department of Interior letter which detailed published studies showing RF impacts to birds. The letter states that “There is a growing level of anecdotal evidence linking effects of non-thermal, non-ionizing electromagnetic radiation from communication towers on

nesting and roosting wild birds and other wildlife.“ It further stated, “the electromagnetic radiation standards used by the Federal Communications Commission (FCC) continue to be based on thermal heating, a criterion now nearly 30 years out of date and inapplicable today.”[3]

Significant research has accumulated indicating substantial risks to wildlife.[4] Studies have found a wide range of impacts, including to orientation, migration, reproduction, mating, nesting, den building, habitat and survivorship with newer technologies creating unique risks for pollinators. Wildlife biologists are urgently calling for updated exposure limits along with safeguards for flora and fauna.[5]

In addition to irrelevant exposure limits, the RF compliance procedures fail wildlife as cell towers and base station antennas are allowed to have non compliance zones that extend sometimes over 50 feet creating hazardous exposures for the animals that live in the air or in trees near the infrastructure. If the FCC fails to address the issue of wildlife exposure and its associated impacts, the consequences will be profound and far-reaching.

---

[3] https://www.ntia.doc.gov/files/ntia/us_doi_comments.pdf

[4] Balmori, A. The incidence of electromagnetic pollution on wild mammals: A new “poison” with a slow effect on nature?. Environmentalist 30, 90–97 (2010).

Cucurachi, S., Tamis, W. L. M., Vijver, M. G., Peijnenburg, W. J. G. M., Bolte, J. F. B., & de Snoo, G. R. (2013). A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). Environment International, 51, 116–140.

Levitt, B. B., Lai, H. C., & Manville, A. M. (2021a). Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment. Reviews on Environmental Health, 37(1), 81–122.

Levitt, B. B., Lai, H. C., & Manville, A. M. (2021b). Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2 impacts: How species interact with natural and man-made EMF. Reviews on Environmental Health, 37(3), 327–406.

[5] Jérémy S. P. Froidevaux, Laura Recuero Virto, Marek Czerwiński, Arno Thielens, and Kirsty J. Park Addressing Wildlife Exposure to Radiofrequency Electromagnetic Fields: Time for Action Environmental Science & Technology Letters, 2024, 11, 1, 3−4

Levitt BB, Lai HC and Manville AM II (2022) Low-level EMF effects on wildlife and plants: What research tells us about an ecosystem approach. Front. Public Health 10:1000840. doi: 10.3389/fpubh.2022.1000840

Levitt, B. B., Lai, H. C., & Manville, A. M. (2021c). Effects of non-ionizing electromagnetic fields on flora and fauna, Part 3. Exposure standards, public policy, laws, and future directions. Reviews on Environmental Health.

For more documentation, see substantial supporting scientific evidence in Appendix 2: Substantial scientific research indicates serious wildlife and environmental impacts of unfettered wireless proliferation.

3. The FCC must require independent premarket safety testing of wireless technologies.

Dr. Ronald Melnick,the International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF) chair and a former senior toxicologist with the U.S. National Toxicology Program at the National Institute of Environmental Health Sciences stated:

> "Many studies have demonstrated oxidative effects associated with exposure to low-intensity RFR, and significant adverse effects including cardiomyopathy, carcinogenicity, DNA damage, neurological disorders, increased permeability of the blood-brain barrier, and sperm damage. These effects need to be addressed in revised and health-protective exposure guidelines. Furthermore, the assumption that 5G millimeter waves are safe because of limited penetration into the body does not dismiss the need for health effects studies."

The United States currently lacks a requirement to test all new technologies (i.e frequency bands, modulations and devices) for potential health or environmental effects before they are introduced to the market.

For example, the FCC greenlighted 5G networks with sub-millimeter and millimeter wave frequencies, which have not been tested for human health and environmental safety. These frequencies have never been deployed commercially on such a large scale. Thus, existing research into the human health effects from long-term exposure to these frequencies is limited.

The FCC regulations erroneously assumes that RF radiation poses risks solely through overheating and the FCC says its 1996 limits easily apply to a wide range of RF frequencies even though the studies these limits were based on decades ago used much lower RF frequencies (under 6 GHz) and did not include studies of millimeter (30 to 300 GHz) or submillimeter waves (300 GHz to 3 THz).

The FCC's approach of treating all RF frequencies as a single category overlooks the critical fact that higher frequencies, such as millimeter waves and sub-THz bands, interact with biological and environmental structures in fundamentally different ways compared to lower frequencies. For instance, millimeter waves predominantly expose the upper layers of human skin, where studies have found they interact with specific structures like sweat ducts, which potentially act as helical antennas and intensify localized energy absorption. Similarly, studies in the European Union have demonstrated that higher frequencies uniquely resonate with smaller organisms, such as insects, leading to increased absorption rates. A 2018 study on insects, including honeybees, revealed that as frequencies approached the resonant frequency of the

insect, the absorbed power increased dramatically, ranging from 3% to 370%, even at the same power level.

As another example, THz frequencies have been greenlighted by the FCC for experimental purposes without proper safety testing. Recent research suggests serious non thermal effects from exposure.

- Li et al. (2025)[6] reported that terahertz irradiation at 2.52 THz enhances angiogenesis in human endothelial cells by increasing intracellular calcium levels, which activates the VEGF signaling pathway, promoting blood vessel formation.
- Wang et al. (2023)[7] reported terahertz radiation impaired the proliferation of neural stem cells and induced apoptosis and DNA damage in a dose-dependent manner, with human neural stem cells exhibiting greater sensitivity compared to mouse neural stem cells.
- Ma et al. (2024)[8] reported exposure to 2.5 THz radiation causes testicular injury in mice by disrupting the blood-testis barrier, inducing oxidative stress, and triggering apoptosis, leading to impaired spermatogenesis.

Safety testing for long term exposure is urgently needed before new technologies are greenlighted. By lumping all RF frequencies together, the FCC fails to account for these unique characteristics and their implications for safety and environmental health. A more nuanced regulatory framework is essential—one that recognizes and addresses the distinct physical and biological interactions of various types of frequencies and technologies.

4. The FCC must ensure adequate post market surveillance regarding RF compliance for devices as well as cell towers.

The U.S. does not have a robust post market surveillance program for cell phones or other wireless devices used in close proximity to the body such as laptops, smart speakers, baby monitors, cordless phone systems and Wi-Fi devices/routers. Before these wireless devices are brought to market, companies must initially provide SAR tests showing compliance to the FCC, but there is no program that verifies the manufacturer's tests or ensures post market compliance.

---

[6] Li J, Guo H, Tan L, Chen M, Wang X, Liu Y, et al. (2025) Terahertz Irradiation Promotes Angiogenesis in vitro by Enhancing Permeability of the Voltage-Gated Calcium Channel. PLoS ONE 20(2): e0317426. https://doi.org/10.1371/journal.pone.0317426

[7] Wang Y., Xiong Y., Chen M., Liu F., He H., Ma Q., Gao P., Xiang G., Zhang L. (2023). The biological effects of terahertz wave radiation-induced injury on neural stem cells. *iScience*, 26(10):107418.

[8] MA Qinlong,LIN Min,GAO Peng,YANG Lingling,LU Yonghui,ZHANG Yanwen,YU Zhengping,CHEN Chunhai.Effects and mechanisms of 2.5T terahertz radiation exposure on testis injury in mice[J].J Amry Med Univ (J Third Mil Med Univ),2024,46(19):2197-2207.DOI:10.16016/j.2097-0927.202311151

Post market compliance tests are critical because devices considered compliant by the manufacturer have been documented to exceed regulatory limits when independently tested. FCC's own laboratory tests[9] found that phones could exceed the FCC's RF limits when tested close to the body (at 2 mm). However, because body contact tests are not required by the FCC, these phones are considered compliant so long as the results of manufacturer's tests (which can use a separation distance of up to 25 mm) stay within the FCC limit.

A 2017 investigation Canadian Broadcasting Corporation tested phones off the shelf and found radiation levels higher than government standards. A 2015 study conducted by the Israeli Ministry for Environmental Protection and the Holon Institute of Technology measured the SARs of several phones and found exceedances when the phone was held close to the head and in poor reception mode.

France has software updated or recalled over 55 models since they launched their robust postmarket surveillance program. All data is posted online and a press release is issued when models are found to exceed limits and when companies take corrective action. The country's post market surveillance program tests cell phones and is expanding to test tablets and other wireless devices for head, trunk and limb SAR. The US needs to catch up with other countries and be a leader in safety.

Decades of insufficient oversight regarding telecommunications network radiofrequency (RF) emissions has led to reports of RF non-compliance issues on rooftop antenna sites. A 2021 RF study by Cardinal Communications, a Division of Thought Delivery Systems, Inc. for THE BALANCE GROUP, used professional grade calibrated spectrum management tools to measure RF levels in a rooftop lounge area next to wireless antennas. They documented significant RF exceedances. According to their Crest Factor analysis, the emissions routinely spiked to 132-to-264% beyond the FCC Human RF exposure standard. This situation likely reflects a systemic issue with rooftop installations nationwide.The RF study was part of a petition submitted to the U.S. Health and Human Services.[10]

---

[9] https://ehtrust.org/press-release-concealed-fcc-cell-phone-radiation-tests-show-human-exposure-limits-were-exceeded/ and https://ehtrust.org/wp-content/uploads/FCC-Letter-on-Cell-Phone-Radiation-Tests-Exceeding-Limits-Appeal-by-EHT-ehtrust.org-.pdf

[10] Americans for Responsible Technology Petition to Health and Human Services, page 225 statement by Sally Jewell Coxe and ATTACHMENT 1 RF Exposure Analysis: 2701 Connecticut Avenue, NW, Washington, DC by Cardinal Communications. https://ehtrust.org/wp-content/uploads/2021-12-21-HHS_FDA-Petition-Final-Filed.pdf

5. The FCC must modernize RF compliance test procedures and the SAR test to reflect current science, today's consumers and the RF exposed (from babies to the medically vulnerable) as well as the real-world use patterns of cell phones and wireless devices.

FCC compliance tests do not reflect today's real world use of cell phones and RF-emitting devices.

To start and most importantly, the SAR SAM test is relevant to health as it only tests for heat. The FCC SAR limit is far too lenient as numerous studies have found effects well below its limit.

The IEEE and ICNIRP SAR limits are also non protective as substantial published research from numerous research institutions across the world have found effects from wireless exposure at orders of magnitude well below current FCC limits. The IEEE, FCC, and ICNIRP limits have been well criticised for a lack of public health protection for humans and they do not address wildlife and environmental impacts.[11]

---

[11] Nyberg R, McCredden J, Hardell L. The European Union assessments of radiofrequency radiation health risks – another hard nut to crack (Review). Reviews on Environmental Health. 2023.

Nyberg, N. R., McCredden, J. E., Weller, S. G., & Hardell, L. (2022). The European Union prioritises economics over health in the rollout of radiofrequency technologies. *Reviews on environmental health*, 10.1515/reveh-2022-0106. Advance online publication.

Nordhagen, Else K. and Flydal, Einar. (2022). Self-referencing authorships behind the ICNIRP 2020 radiation protection guidelines. *Reviews on Environmental Health*.

Ben Ishai, P., Davis, D., Taylor, H., & Birnbaum, L. (2022). Problems in evaluating the health impacts of radio frequency radiation. *Environmental research*, 115038. Advance online publication.

International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF), (2022). Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: implications for 5G. Environ Health. Oct 18;21(1):92.

McCredden, J. E., Weller, S., & Leach, V. (2023). The assumption of safety is being used to justify the rollout of 5G technologies. *Frontiers in public health*, *11*, 1058454.

Nilsson M, Hardell L, Ketti M, Wells N, Nyberg R, Halmøy S, Midelthon TJ, Glomsrød S, Schriver P. Nordic Appeal: More Stringent Regulatory Framework on Microwave Radiation from Wireless Technologies is Needed - Stop Further Rollout of 5G. Ann Clin Med Case Rep. 2023; V10(13): 1-4.
Lin J. C. (2023). Incongruities in recently revised radiofrequency exposure guidelines and standards. *Environmental research*, *222*, 115369.

In 2022, Dr. Henry Lai and B. Blake Levitt reviewed 112 low-intensity wireless radiation studies, finding biological effects at a median SAR of just 0.0165 W/kg. They recommend a full-body SAR limit of 0.00165 W/kg—48 times lower than current FCC limits—due to a wide range of low-level health effects including oxidative stress and DNA damage.

The paper was published in the peer-reviewed journal, Electromagnetic Biology and Medicine.

> *"RFR effects have been observed at low intensities (< 0.4 W/kg) – a list of which is included in Supplement 1 – far below the guidelines. This points to both the nonlinearity of how living systems couple with nonionizing radiation as well as the inadequacy of acute thresholds. The studies encompass many different biological effects to myriad systems, including: apoptosis induction, adrenal gland activity, blood–brain barrier permeability, brain transmitter levels, calcium concentration in heart muscle, calcium efflux, calcium movement in cells, cell growth, cognitive functions, cellular damage in liver, decreased cell proliferation, embryonic development, endocrine changes, enolose activity, genetic effects, hippocampal neuronal damage, immunological functions, kidney development, memory functions, latency of muscular contraction, membrane chemistry, nerve cell damage, metabolic changes, neural electrical activity, oxidative stress, plant growth, prion level, protein changes, renal injury, serum testosterone concentration, heat-shock protein induction, testis morphology, testosterone synthesis, thymidine incorporation, and ultrastructural alteration in cell cytoplasm. In fact, there are not many physiological functions in humans, animals, or plants that are not affected by low-level RFR."*

Below are just a few examples of the significant published research that has found adverse effects at levels well below levels the FCC limits.

Uche et al. (2021)[12] concluded that FCC limits should be strengthened by 200–400 times to protect children, based on tumor and heart damage observed in the National Toxicology Program's large-scale RF study. The FCC must consider this publication and strengthen limits accordingly.

J. C. Lin.(2022). "Health Safety Guidelines and 5G Wireless Radiation [Health Matters]" in *IEEE Microwave Magazine*, vol. 23, no. 1, pp. 10-17.

Panagopoulos, D. J. (Ed.). (2022). *Electromagnetic Fields of Wireless Communications: Biological and Health Effects* (1st ed.). CRC Press.

Davis, D., Birnbaum, L., Ben-Ishai, P., Taylor, H., Sears, M., Butler, T., & Scarato, T. (2023). Wireless technologies, non-ionizing electromagnetic fields and children: Identifying and reducing health risks. *Current Problems in Pediatric and Adolescent Health Care*, *53*(2), 101374.

[12] Uche, U. I., & Naidenko, O. V. (2021). Development of health-based exposure limits for radiofrequency radiation from wireless devices using a benchmark dose approach. *Environmental Health*, *20*(1), 84.

A joint study[13] Dagro et al (2021) by the U.S. Army and Air Force Research Labs found that high-powered pulsed microwave exposure could cause brain injuries similar to explosive blasts and football head impacts—even at levels deemed safe by FCC RF limits.

Sharma et al. (2022)[14] exposed rats to 2100 MHz RF at an SAR of 0.453 W/kg—below FCC limits—and observed inflammation, hippocampal degeneration, and mitochondrial damage, concluding chronic exposure may impair neural communication.

Moretti et al. 2023[15] exposed neuronal networks to GSM-1800 signals at 3.2 W/kg and recorded a 30% reversible decrease in neuronal firing and bursting rates after just three minutes.

In Cantu et al. 2023,[16] a team from both General Dynamics Information Technology as well as the Air Force Bioeffects Lab in Texas, showed that one hour of weak 900 MHz RF exposure

---

[13] A. M. Dagro, J. W. Wilkerson, T. P. Thomas, B. T. Kalinosky, and J. A. Payne, "Computational modeling investigation of pulsed high peak power microwaves and the potential for traumatic brain injury," Sci. Adv., vol. 7, no. 44, pp. 1–10, Oct. 2021, doi: 10.1126/sciadv. abd8405. https://www.science.org/doi/10.1126/sciadv.abd8405 "Nevertheless, the simulations here have shown that exceptionally intense HPM exposures with incident power densities greater than 1.5 × 106 mW/cm2 (at short pulse durations) may generate intracranial stresses that are similar (±~20 to 200 kPa) in comparison to typical TBI events (sports, vehicle accidents, ballistic impact, etc.). For sufficiently short microwave pulse durations (<τc), large tensile stresses are created in the deep regions of the brain…While the peak power densities used within this simulation study are large, they are achievable with known microwave hardware. For example, to produce a power density of 1 × 106 mW/cm2 at 25 m away from a 40-dBi antenna, a microwave source would require approximately 8 MW of power per pulse. This is within the capabilities of some commercial and military systems, and we therefore consider this as a relevant approximation for the simulations here. However, we also consider some more extreme conditions in the final analysis summary for scaling purposes against known mechanical TBI thresholds." See also Lin, J. C. (2023). A Paradigm Shift? IEEE Microw. https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=10314707

[14]Sharma A, Shrivastava S, Singh A, Gupte SS, Rathour A, Reshi MS, Shukla S. Evidences of the radiofrequency exposure on the antioxidant status, potentially contributing to the inflammatory response and demyelination in rat brain. Environ Toxicol Pharmacol. 2022 Aug;94:103903. https://www.sciencedirect.com/science/article/abs/pii/S1382668922000965?via%3Dihub

[15] Moretti, M., Villarini, M., Simonucci, S., Fatigoni, C., Scassellati-Sforzolini, G., Monarca, S., Pasquini, R., Angelucci, M., & Strappini, M. (2005). Effects of co-exposure to extremely low frequency (ELF) magnetic fields and benzene or benzene metabolites determined in vitro by the alkaline comet assay. *Toxicology Letters*, *157*(2), 119–128. https://onlinelibrary.wiley.com/doi/10.1002/bem.21805

[16]Cantu, J. C., Butterworth, J. W., Peralta, X. G., Payne, J. A., & Echchgadda, I. (2023). Analysis of global DNA methylation changes in human keratinocytes immediately following exposure to a 900 MHz radiofrequency field. Bioelectromagnetics, 44(3–4), 77–89.

(under 0.01 W/kg) caused significant DNA methylation changes in human skin cells, demonstrating epigenetic effects far below FCC safety levels. 114 genes were “significantly differentially methylated.

DNA methylation has been described as “a major epigenetic factor influencing gene activities and improper methylation of a single gene can have “drastic consequences.”

Panagopoulos 2020[17] studied human lymphocytes exposed at 1 cm distance from a cell phone in “talk” mode as well as those treated with a high caffeine dose (290 times higher than a permissible single dose for human exposure). Not only did the cell phone exposure induce greater impacts than the caffeine dose, but also, the combination of the caffeine dose and the 15 min cell phone EMF exposure dramatically increased the genotoxic action. Panagopoulos 2024[18] documented cell phone EMF exposure at a power density ~136 times below the latest International Commission on Non-Ionizing Radiation Protection (ICNIRP) exposure limit significantly enhanced the genotoxic action of gamma radiation.

Gautam et al. (2023)[19] exposed rats to 4G radiation at a whole body SAR 0.0625 W/kg and observed decreased sperm viability, testosterone levels, and organ damage, suggesting chronic low-level RF exposure affects male reproductive and organ systems.The authors conclude that, “chronic exposure to 4G radiation may affect the male reproductive system, hematological system, liver, and kidney of rats.”

Patrignoni et al. (2023)[20] found that 24-hour exposure to a 5G signal at 3.5 GHz was able to statistically significantly alter the mitochondrial reactive oxygen species (ROS) production in human skin fibroblasts (decrease at 1 W/Kg) and in human keratinocytes after UV-B irradiation (increase at 0.25 and 1 W/kg).

---

[17]Panagopoulos DJ. Comparing chromosome damage induced by mobile telephony radiation and a high caffeine dose: Effect of combination and exposure duration. Gen Physiol Biophys. 2020 Nov;39(6):531-544. https://www.elis.sk/index.php?page=shop.product_details&flypage=flypage.tpl&product_id=7009&category_id=161&option=com_virtuemart&vmcchk=1&Itemid=1

[18] Panagopoulos DJ. Mobile telephony radiation exerts genotoxic action and significantly enhances the effects of gamma radiation in human cells. Gen Physiol Biophys. 2024 Mar;43(2):103-120. doi: 10.4149/gpb_2023036. Epub 2023 Dec 8. PMID: 38099580.http://www.elis.sk/index.php?page=shop.product_details&flypage=flypage.tpl&product_id=8263&category_id=195&option=com_virtuemart&vmcchk=1&Itemid=1

[19]Gautam R, Pardhiya S, Nirala JP, Sarsaiya P, Rajamani P. Effects of 4G mobile phone radiation exposure on reproductive, hepatic, renal, and hematological parameters of male Wistar rat. Environ Sci Pollut Res Int. 2023 Dec 16

[20] Patrignoni L, Hurtier A, Orlacchio R, Joushomme A, Poulletier de Gannes F, Lévêque P, Arnaud-Cormos D, Revzani HR, Mahfouf W, Garenne A, Percherancier Y, Lagroye I. Evaluation of mitochondrial stress following ultraviolet radiation and 5G radiofrequency field exposure in human skin cells. Bioelectromagnetics. 2023 Dec 19

Panagopoulos et al. (2010)[21] showed fruit flies exposed to mobile phone signals had significant reproductive harm and cell death even at low intensities (as low as 1 μW/cm²), with effects peaking at 20–30 cm from the antenna.

Lee et al. (2005)[22] found cultured human HL-60 cells exposed to pulsed RF fields at 2.45 GHz altered expression in 221 genes after a 2-h exposure. The number of affected genes increased to 759 after a 6-h exposure. “These results indicate that the RF fields at 2.45 GHz can alter gene expression in cultured human cells through non-thermal mechanism.”

Kues et al. (1992)[23] at Johns Hopkins reported that low-level microwave exposure (SAR 0.26 W/kg) caused serious eye damage in monkeys, including visual impairment and retinal degeneration—effects amplified with ophthalmic drug use.

Dahon et al. (2025)[24] demonstrated that human cells react to extremely weak 1.8 GHz RF exposures, causing oxidative stress responses and gene modulation far below thermal thresholds—within signal levels of typical Wi-Fi and cell phones.

Tests must be modernized to protect for biological impacts.

In addition, these issues need to be addressed.

1. Phones are *not required to be RF tested in body contact positions* such as in a pants pocket, or pressed to the abdomen or lap. They should be. But instead, federally approved compliance test procedures use “standardized” positions that were set in 1996, when phones were clipped to the belt in holsters, allowing for space between the device and the body. Manufacturers can choose a separation distance (up to 25 mm) for testing cell phones and devices against the SAM model. While the FCC has issued interim guidance that would restrict the distance to 5mm, they need to set any cell phone tests to be at 0 mm, the way people use devices today.

---

[21] Panagopoulos DJ, Chavdoula ED, Margaritis LH. Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. Int J Radiat Biol. 2010 May;86(5):345-57.
[22] Lee S, Johnson D, Dunbar K, Dong H, Ge X, Kim YC, Wing C, Jayathilaka N, Emmanuel N, Zhou CQ, Gerber HL, Tseng CC, Wang SM. 2.45 GHz radiofrequency fields alter gene expression in cultured human cells. FEBS Lett. 2005 Aug 29;579(21):4829-36.
[23] Kues HA, Monahan JC, D'Anna SA, McLeod DS, Lutty GA, Koslov S. Increased sensitivity of the non-human primate eye to microwave radiation following ophthalmic drug pretreatment. Bioelectromagnetics. 1992;13(5):379-93. doi: 10.1002/bem.2250130505. PMID: 1445419.

[24] Dahon, C., Aguida, B., Lebon, Y., Le Guen, P., Dangremont, A., Meyer, O., Citerne, J.-M., Pooam, M., Raad, H., Thoradit, T., Jourdan, N., Bertagna, F., & Ahmad, M. (2025). A Novel Method for Achieving Precision and Reproducibility in a 1.8 GHz Radiofrequency Exposure System That Modulates Intracellular ROS as a Function of Signal Amplitude in Human Cell Cultures. *Bioengineering*, *12*(3), 257. https://doi.org/10.3390/bioengineering12030257

2. Compliance test positions must address the multitude of ways people hold devices up to their bodies. Babies hold the entire phone against her abdomen. People rest the entire phone on their cheat. Here are some examples.

Grasshopper
Sponsored
Put your best voice forward
Grasshopper
A virtual phone system built for small business owners
Try it Free
SIGNUP.GRASSHOPPER.COM
Ready when business calls.
Add a business line to your personal phone with our top-rated virtual pho...
Learn more

3. The SAR laboratory set up omits real world environmental factors which can significantly impact a user or bystander's actual RF radiation exposure. For example, studies have documented how metal can refocus and reflect RF, creating hotspots in tissues. Specifically, *in body* metal such as metal implants and pacemakers and *on body* metal such as eyeglasses, piercings and jewelry have been found to increase RF absorption rates inside the body, sometimes resulting in exceedances of the limit. Yet these factors are not accounted for in the FCC test regime. These real world aspects of exposure must be addressed.

4. Compliance tests do not consider the combined exposure from numerous sources[25] of various frequencies.[26]
5. Compliance tests must consider medical vulnerabilities as some people are more sensitive to others, be it genetic, a chronic health condition[27], age, or their use of drugs or co-exposures with other toxins.[28]

---

[25] Salah I. Yahya, Yazen A. Khalil, Numerical Computation of the Combined Specific Absorption Rates Induced in Human Head due to Multiple Independent Sources, *International Journal of Electromagnetics and Applications*, Vol. 5 No. 2, 2015, pp. 73-79. doi: 10.5923/j.ijea.20150502.01.
N. E. Soares, G. Bulla, C. E. Fernandez-Rodriguez and A. A. A. de Salles, "SAR Estimations in a Child Due to RF Exposures from Several Laptops in a Classroom Environment," *2023 IEEE MTT-S Latin America Microwave Conference (LAMC)*, San José, Costa Rica, 2023, pp. 58-60, doi: 10.1109/LAMC59011.2023.10375589.

N. E. Soares, G. Bulla, C. E. Fernandez-Rodriguez and Á. A. A. De Salles, "Analysis of Exposure to Electromagnetic Fields Due to Multiple Sources in a Classroom Environment," *2023 SBMO/IEEE MTT-S International Microwave and Optoelectronics Conference (IMOC)*, Castelldefels, Spain, 2023, pp. 28-30, doi: 10.1109/IMOC57131.2023.10379728.

[26] Sun L, Wang X, Ren K, Yao C, Wang H, Xu X, Wang H, Dong J, Zhang J, Yao B, Wei X, Peng R, Zhao L. Compound exposure of 2.8 GHz and 9.3 GHz microwave causes learning and memory impairment in rats. Heliyon. 2025 Jan 3;11(1):e41626. doi: 10.1016/j.heliyon.2025.e41626. PMID: 39866417; PMCID: PMC11760294.

Accumulative Effects of Multifrequency Microwave Exposure with 1.5 GHz and 2.8 GHz on the Structures and Functions of the Immune System
https://pubmed.ncbi.nlm.nih.gov/36981897/

Oxidative stress and energy metabolism in male reproductive damage from single and combined high-power microwave exposure at 1.5 and 4.3GHz
https://pubmed.ncbi.nlm.nih.gov/39617305/

Lai Y, Wang H, Xu X, Dong J, Song Y, Zhao H, Wu Y, Zhao L, Wang H, Zhang J, Yao B, Zou Y, Zhou H, Peng R. Hippocampal ferroptosis is involved in learning and memory impairment in rats induced by microwave and electromagnetic pulse combined exposure. Environ Sci Pollut Res Int. 2023 Jul;30(35):83717-83727. doi: 10.1007/s11356-023-28280-8.

[27] Bektas H, Algul S, Altindag F, Yegin K, Akdag Z, Dasdag S. (2022). Effects of 3.5 GHz (5G) Radiofrequency Radiation on Ghrelin, Nesfatin-1, and Irisin Levels in Diabetic and Healthy Brains. J Chem Neuroanat. 2022 Oct 8:102168.

[28] Benavides, R. A. S., Leiro-Vidal, J. M., Rodriguez-Gonzalez, J. A., Ares-Pena, F. J., & López-Martín, E. (2023). The HL-60 human promyelocytic cell line constitutes an effective in vitro model for evaluating toxicity, oxidative stress and necrosis/apoptosis after exposure to

6. Compliance tests must test for exposures to extremities as well as body and head. All parts of the body must be evaluated.
7. Compliance tests for devices must consider children's use as well as exposure to the developing pregnancy. Children are not little adults. Even if the exposure were the same or less, children and the fetus are considered more vulnerable due to their rapid development. The cells in children and fetuses divide rapidly, providing more opportunities for radiation exposure to disrupt the process and cause cell damage. No federal agency has ever evaluated children's higher exposures and unique vulnerability, or reviewed the accumulated scientific evidence on prenatal or postnatal childhood exposure to characterize risk and make a recommendation on the safety factors needed to protect them.

---

black carbon particles and 2.45 GHz radio frequency. *The Science of the Total Environment*, *867*, 161475.

Boga, A., Emre, M., Sertdemir, Y., Akillioglu, K., Binokay, S., & Demirhan, O. (2015). The effect of 900 and 1800 MHz GSM-like radiofrequency irradiation and nicotine sulfate administration on the embryonic development of Xenopus laevis. *Ecotoxicology and Environmental Safety*, *113*, 378–390.

Byun, Y.-H., Ha, M., Kwon, H.-J., Hong, Y.-C., Leem, J.-H., Sakong, J., Kim, S. Y., Lee, C. G., Kang, D., Choi, H.-D., & Kim, N. (2013). Mobile Phone Use, Blood Lead Levels, and Attention Deficit Hyperactivity Symptoms in Children: A Longitudinal Study. *PLOS ONE*, *8*(3), e59742.

Khodamoradi E, Afrashi S, Khoshgard K, Fathi F, Shahasavari S, Azmoonfar R, Najafi M. Simultaneous effect of gamma and Wi-Fi radiation on gamma-H2Ax expression in peripheral blood of rat: A radio-protection note. Biochem Biophys Rep. 2022 Feb 23;30:101232. doi: 10.1016/j.bbrep.2022.101232. PMID: 35243013; PMCID: PMC8881645.

Kostoff, R.N., Lau, C.G.Y. (2017). Modified Health Effects of Non-ionizing Electromagnetic Radiation Combined with Other Agents Reported in the Biomedical Literature. In: Geddes, C. (eds) Microwave Effects on DNA and Proteins. Springer, Cham. https://doi.org/10.1007/978-3-319-50289-2_4

Kostoff RN, Goumenou M, Tsatsakis A. The role of toxic stimuli combinations in determining safe exposure limits. Toxicol Rep. 2018 Nov 7;5:1169-1172. doi: 10.1016/j.toxrep.2018.10.010. PMID: 30627517; PMCID: PMC6320263.

Lerchl, A., Klose, M., Grote, K., Wilhelm, A. F. X., Spathmann, O., Fiedler, T., Streckert, J., Hansen, V., & Clemens, M. (2015). Tumor promotion by exposure to radiofrequency electromagnetic fields below exposure limits for humans. *Biochemical and Biophysical Research Communications*, *459*(4), 585–590.

López-Álvarez C, López-Martín ME, Rodríguez-González JA, Ares-Pena FJ. A Review on the Effects of Thermal Inversions and Electromagnetic Fields on Cell Cultures and Wireless Communications. Sensors (Basel). 2023 Dec 2;23(23):9567.

Numerous scientists recommend more stringent RF limits to protect children. A 2000 Ecolog Institute Report commissioned by T-Mobile recommended an exposure limit 1000 times *lower than* the FCC's current power density limit after reviewing the research on biological effects, including impacts to the immune system, central nervous system, hormones, cancer, neurotransmitters and fertility. Independent analysis of the NIH/NTP studies concluded that FCC limits needed to be strengthened by 200 to 400 times to protect children according to current risk assessment guidelines.

6. The FCC must pause further 5G and new wireless technology expansion until independent research verifies safety.

The FCC has a responsibility to protect public health and the environment, yet current safety guidelines are based on outdated research that does not account for the biological effects of chronic, low-level, or high-frequency exposures—particularly from emerging technologies like 5G and terahertz radiation. Without comprehensive, peer-reviewed, and independent research verifying the safety of these technologies, continuing their rapid deployment risks causing irreversible harm to human health, wildlife, and ecosystems. A pause would allow time for rigorous investigation, transparent review, and the development of science-based safety standards that reflect current evidence.

7. The FCC must reinstate local authority over cell towers and 5G/4G "small cell and wireless facility infrastructure deployment.

Local governments must have the authority to make decisions about the placement, density, and aesthetics of wireless infrastructure in their communities to protect public health, preserve property values, preserve sensitive ecological areas and maintain community character. When the FCC preempts local control, it undermines the ability of municipalities to respond to their resident's concerns and ensure that deployments are responsibly placed.

However, the FCC significantly curtailed local authority over wireless infrastructure deployment through its 2018 Declaratory Ruling and Third Report and Order (FCC 18-133). This order preempted many local controls over the siting and regulation of 4G/5G small cell wireless facilities. While the FCC argued that these steps were necessary to accelerate the rollout of 5G services, many municipalities contended that the rules undermined local autonomy and failed to account for community-specific concerns. **This ruling should be deleted.**

Residents are furious when they learn their local authority's "hands are tied." Reinstating local authority is essential to restoring public trust in wireless infrastructure planning.

8. The FCC must address regulatory capture at the agency and the undue influence of the wireless industry.

In 2015, the Harvard Edmund J. Safra Center for Ethics published an expose on the FCC and the wireless industry by investigative journalist Norm Alster documenting how the wireless industry has bought inordinate access to—and power over—a major US regulatory agency. He describes how the FCC is a "captured agency" meaning it is controlled by the very industry it is supposed to be regulating- like the wolf watching the henhouse. Alster documented the "revolving door" between the wireless industry and its government regulators with key examples of how FCC commissioners previously held, or later held top positions in the wireless industry lobby associations.

In 2020 Bloomberg News reported that the tech industry has become one of the biggest spenders in Washington and is rivaling the pharmaceutical industry and big business lobbies. Together, the five biggest tech companies shelled out $62.2 million in 2019- more than double the $28.9 million spent by the pharmaceutical industry's lead trade group.

> "Internet service providers in the United States have spent more than $1.2 billion on lobbying since 1998, and 2018 was the biggest year so far with a total spend of more than $80 million…Top spenders include AT&T, Verizon, and Comcast, which have amassed lobbying expenses of $341 million, $265 million, and $200 million, respectively since 1998."- Paul Bischoff from CompariTech

The Revolving Door of the U.S. FCC Commissioners: A Few Examples

The FCC Commissioners past and present are part of the revolving door between industry, government and the law firms attacking our right to know about wireless radiation. Furthermore several FCC commissioners/lead staff previously worked for law firms -Wiley Rein and Gibson, Dunn & Crutcher- that represented the wireless industry in cell phone brain cancer cases and the wireless industry's fight to stop laws that inform consumers about cell phone radiation. Wiley Rein represented the wireless industry against the City of San Francisco and Gibson, Dunn & Crutcher represented the wireless industry against the city of Berkeley.

Tom Wheeler: In 2013, President Obama appointed the former Chair of the CTIA Wireless Industry, Tom Wheeler, to Chair the FCC. During his reign from 2013-2017, Wheeler made 5G "a national priority" and championed the commission to open up vast amounts of spectrum for 5G applications. Wheeler joined the Brookings Institute after leaving the FCC and his writings and opinions are considered highly influential figure in the telecommunications space. For example, a 2022 U.S. government Government Accountability Report featured Wheeler in it's 5G explainer video. AT&T and T-Mobile are unrestricted donors to the Brookings Institution.

Ajit Pai: President Obama appointed former Verizon lawyer, Ajit Pai as an FCC Commissioner and in 2017, President Trump tapped Pai to replace Tom Wheeler as Chair of the FCC. After Biden took office, Pai stepped down in 2021 to work at the private-equity firm Searchlight

Capital where “he will focus on steering investments in telecom infrastructure.” In 2025 he became the new head of the CTIA Wireless Industry.

Brendan Carr: Telecom lawyer Brendan Carr was appointed FCC Commissioner by President Trump in 2017 He had previously worked for Verizon as well as Wiley Rein, where he was co-counsel for the CTIA wireless industry in their attack against the City of San Francisco for it’s Cell Phone Right to Know Ordinance.

Meredith Attwell Baker: Current President and CEO of the CTIA Wireless Association Meredith Attwell Baker was nominated by President Obama as an FCC Commissioner. Previous to the FCC, Baker had served in the Bush Administration as the acting administrator of the National Telecommunications and Information Administration and even earlier in her career was director of congressional affairs for CTIA Wireless Industry. Under President Obama’s ethics pledge, Baker was restricted from lobbying the FCC for two years after she left the Commission, but she could lobby Congress. So she did. She left the FCC to immediately take a position as lead lobbyist for NBC Universal. Then, in 2014, Baker became President of the CTIA Wireless Industry until 2025.

Michael Powell

President & CEO of the Internet & Television Association (NCTA), Michael K. Powel,l is the former chairman of the Federal Communications Commission. He was first nominated to the Commission by President Bill Clinton and later designated its chair by President George W. Bush. NCTA is one of the largest trade associations in Washington, D.C., representing the communications and content industries. Powell also served on the boards of Cisco and AOL.

Nathan A. Simington

FCC Commissioner Nathan A. Simington was formerly senior counsel to Brightstar Corporation, “the leading trader in used wireless devices.” After working at Brightstar, Simington served in the Department of Commerce for five months, until President Trump nominated him as an FCC commissioner.

William Kennard

Former Chair of the U.S. FCC, Wiliam Kennard, is now Chair of the Board of Directors of AT&T, Inc. He also serves on the boards of Yale University, Duke Energy Corp, MetLife, Inc. and Ford Motor Company. After leaving the FCC, Kennard served as the U.S. Ambassador to the European Union working to promote transatlantic trade and investment and to eliminate regulatory barriers. He co-founded and serves as chairman of Velocitas Partners LLC, an asset management firm and is co-founder of private equity firm Astra Capital Management.

The Revolving Door of FCC Lawyers to Wireless Industry Law Firms

Thomas M. Johnson

Thomas M. Johnson was appointed as general counsel of the FCC by FCC Commissioner Ajit Pai. He filed two FCC statements of interest that successfully persuaded two federal district courts that the City of Berkeley's "right-to-know" ordinance for cell-phone retailers, and alleged class-action tort claims against Apple, were preempted by FCC rules on radiofrequency emission limits. *Before working at the FCC*, he had worked at Gibson, Dunn & Crutcher -the firm that represented the CTIA in their case against the City of Berkeley for it's cell phone right to know ordinance. In 2021, he left the FCC and joined the CTIA tied law firm of Wiley Rein as a partner and co-chair of the firm's Appellate Practice.

Bruce Romano
Bruce Romano served as legal chief in the FCC's Office of Engineering and Technology and then left to serve as counsel at the law firm of Wiley Rein.

9. FCC must ensure consumers are informed about the Wireless radiation and fine print warnings.

Most U.S. consumers are unaware that wireless devices emit radiofrequency (RF) radiation or that scientific studies have raised safety concerns about this type of radiation. In 2011, the World Health Organization's International Agency for Research on Cancer classified RF radiation as a Group 2B possible carcinogen. In response, states including California, Hawaii, Maine, Oregon and Pennsylvania proposed legislation to label cell phones with RF exposure information, but these efforts were unsuccessful. Although Berkeley and San Francisco passed "Right to Know" laws for cell phone RF emissions, implementation was blocked by lawsuits from the telecom industry.

Currently, if a consumer wishes to determine the Specific Absorption Rate (SAR) of a device, they must navigate the FCC's complex database. The process involves identifying the FCC ID of the device, accessing a corresponding webpage, and sifting through extensive technical documentation to locate SAR values, RF exposure details, and recommended separation distances. Companies often bury this information in user manuals or obscure sections of their websites, making it inaccessible to the average consumer.

> "iPhone is evaluated in positions that simulate uses against the head, with no separation, and when worn or carried against the torso of the body, with 5 mm separation…To reduce exposure to RF energy, use a hands-free option, such as the built-in speakerphone, headphones or other similar accessories."
> -Apple iPhone 13

> "Body-worn SAR testing has been carried out at a separation distance of 1.5 cm. To meet RF exposure guidelines during body-worn operation, the device should be positioned at least this distance away from the body."

-Samsung Galaxy Z Fold 3 5G

“Body-worn Operation This device was tested for typical use with the back of the device kept 0.39 inches (1.0 cm) from the body. To comply with FCC RF exposure requirements, a minimum separation distance of 0.39 inches (1.0 cm) must be maintained between the user’s body and the back of the device.”
-LG G8 page 166

“Use accessories such as a carrying case, etc., to keep the product at least 1.5 inches away from your body, and make sure there is no metal (part) in between.”
-Docomo Smartphone (Japan) SC-51C(Galaxy S22)

“This device has also been tested and meets the FCC RF exposure guidelines for use with an accessory that contains no metal and positions the handset a minimum of 15mm from the body. Position the handset a minimum of 15mm from your body when the device is switched on.”
OnePlus 8 5G UW User Guide

“…it is advised to use the Products in such a manner that minimizes the potential for human contact during normal operation.” “This Device should be installed and operated with at least 20 cm between the radiator and your body.”
-Amazon Echo Dot (4th Generation) Kids Edition Safety and Compliance

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.”
–Samsung Smart TV 6200 User Manual

“This device should be installed and operated with a minimum distance of 20 cm between the radiator and your body.”
–Amazon Echo

This device should be operated with a minimum separation distance of 20 cm (8 inches) between the equipment and a person’s body.”
–Apple iMac Regulatory Compliance Info OS Monterery 12

"When placing the Apple Watch near your face, keep at least 10 mm of separation to ensure exposure levels remain at or below the as-tested levels."
–Apple Watch Model A1553

"To be sure that human exposure to RF energy does not exceed the FCC, IC, and European Union guidelines, always follow these instructions...Orient the device in portrait mode with the Home button at the bottom of the display, or in landscape mode with the cellular antenna away from your body or other objects."
-Apple iPad IOS4 Important Product Information Guide

"This equipment should be installed and operated with at least 20 cm (8 inches) or more between the radiator and the person's body." -Playstation 4 Pro

"This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the
radiator and your body."
-OC1A Owlet Baby Camera User Manual

Professor Om Gandhi, one of the engineers who led the development of IEEE human exposure standards decades prior, found that most cell phone models tested by the French government ANFR would exceed the U.S. FCC limit, if tested in 0 mm positions, and some phone models would exceed it by three to up to eleven-fold supporting earlier publications finding exceedences at close body contact.[29]

---

[29] Gandhi, O. P. (2019). Microwave Emissions From Cell Phones Exceed Safety Limits in Europe and the US When Touching the Body. *IEEE Access, 7*, 47050–47052.

Gandhi, O. P. and Kang, G. (2004). Inaccuracies of a plastic "pinna" SAM for SAR testing of cellular telephones against IEEE and ICNIRP safety guidelines, *IEEE Transactions on Microwave Theory and Techniques*, 52(8), 2004-2012.

Gandhi, O. P. and Kang, G. (2004). Some present problems and a proposed experimental phantom for SAR compliance testing of cellular telephones at 835 and 1900 MHz - IOPscience. *Physics in Medicine & Biology*, 47(9), 1501.

Kang, G and Gandhi, O. P. (2002). SARs for pocket-mounted mobile telephones at 835 and 1900 MHz. *Physics in Medicine & Biology*, 47(23), 4301.

In contrast, many other countries prioritize transparency and consumer awareness and education. Nations such as France, Israel, India, Belgium, Russia, and Korea have laws mandating more visible RF information. For example, SAR levels are prominently displayed online or at points of sale. France conducts post-market RF testing and publishes results in a database that's searchable by make and model.

Additionally, many countries provide clear guidance on how to reduce exposure, especially for vulnerable populations like children. In France, mandated wireless device consumer information includes recommendations for reducing RF by using speaker phone, minimizing children's exposure and "Keep[ing] radio equipment away from the belly of pregnant women" and "away from the lower abdomen of adolescents."

Several countries have robust websites addressing various devices from phones to Wi-Fi to baby monitors. The FCC must ensure full transparency for consumers.

To empower consumers and promote informed decision-making, the FCC should provide robust, comprehensive website pages on the latest EMF science and how to reduce exposure, including safe alternatives to wireless, such as corded and ethernet connected technology. Policies should require all wireless devices to display RF information at the point of sale, on product packaging, and online in user-friendly formats.These labels should include:

- *RF Emission Disclosure: Clearly state that the device emits RF radiation.*
- *Measured RF Levels: Provide SAR data and other relevant exposure metrics.*
- *Practical Reduction Strategies: Offer actionable steps to minimize exposure tailored to each type of device.*

Such measures would align the U.S. with global best practices, ensuring consumers have the information necessary to make safer choices regarding cell phones and wireless devices.

10. Cost-benefit considerations support modernizing wireless radiation limits.

Failure by the FCC to implement the recommended measures will likely result in significant harm to human health and the environment, as well as substantial financial consequences

> "Given that treatment for a single case of brain cancer can cost between $100,000 for radiation therapy alone and up to $1 million depending on drug costs, resources to address this illness are already in short supply and not universally available in either developing or developed countries. Significant additional shortages in oncology services are expected at the current growth of cancer. No other environmental carcinogen has produced evidence of an increased risk in just one decade."
> -Davis et al. 2013 Swedish review strengthens grounds for concluding that radiation from cellular and cordless phones is a probable human carcinogen

Ensuring federally developed science based safety standards makes both economic and public health sense, as demonstrated by compelling evidence on the costs of exposure to harmful chemicals. Here are some examples:

- Research led by Dr. Trasande, published in *The Journal of Clinical Endocrinology & Metabolism*, found that endocrine-disrupting chemicals cost the EU approximately €157 billion ($209 billion) annually—1.23% of its GDP. One major contributor, flame-retardant PBDEs, was linked to 11 million lost IQ points, 43,000 cases of intellectual disability, and a staggering $266 billion in related costs.[30]
- Pesticide exposure resulted in 1.8 million lost IQ points and 7,500 new disability cases per year, adding another $44.7 billion in health-related expenses. These findings underscore the high cost of inaction and highlight the far greater value of proactive prevention strategies.
- In 2019, global lead exposure was estimated to cost $6.0 trillion—equivalent to 6.9% of global GDP—through the loss of 765 million IQ points in children and 5.5 million adult cardiovascular deaths, with low- and middle-income countries bearing over 90% of the burden.[31]

Truly protective wireless radiation limits along with robust oversight and enforcement measures would result in great financial benefits to the country. Beyond personal health, the broader economic impact is substantial: fewer chronic health issues can mean lower long-term healthcare costs, less strain on public health systems, and improved productivity due to better sleep, focus, and well-being.

Investing in safer, wired technologies may carry modest upfront costs, but they can lead to major savings over time through reduced medical expenses, fewer sick days, and a healthier, more resilient population—just as lead-free infrastructure proved to be not only safer, but smarter economically.

Respectfully Submitted
Theodora Scarato
Director, Wireless and EMF Program
Environmental Health Sciences

All links included by reference.

Appendix 1: Substantial scientific research indicates serious human health impacts from continued wireless proliferation.

[30] https://academic.oup.com/jcem/article-abstract/100/4/1245/2815065?redirectedFrom=fulltext
[31] https://www.sciencedirect.com/science/article/pii/S2542519623001663#:~:text=The%20total%20global%20cost%20of,6%E2%80%9315%C2%B76).

Appendix 2: Substantial scientific research indicates serious wildlife and environmental impacts of unfettered wireless proliferation

Appendix 3: Substantial scientific research has found these effects well below current FCC limits.

Appendix 4: Theodora Scarato Submissions of scientific research and policy reports that support this comment.

Appendix 1: Substantial scientific research indicates serious human health impacts from continued wireless proliferation. Here are some examples.

Abtin S, Seyedaghamiri F, Aalidaeijavadi Z, Farrokhi AM, Moshrefi F, Ziveh T, Zibaii MI, Aliakbarian H, Rezaei-Tavirani M, Haghparast A. A review on the consequences of molecular and genomic alterations following exposure to electromagnetic fields: Remodeling of neuronal network and cognitive changes. Brain Research Bulletin, Volume 217, 2024. doi: 10.1016/j.brainresbull.2024.111090.

Alliance of Nurses for Healthy Environments. (n.d.). *E-Textbook – Environmental Health in Nursing*

Timothy A. Attah, Benjamin Ayantunji, Abubakar Adamu, Ameh Omede, Jeffree Leleji et al. (2022). Biological Effects of High Radiofrequency Radiation on Wistar Rats: A Literature Review. *Journal of Public Health International*, 5(2),1-31

Bandara, P., & Carpenter, D. O. (2018). Planetary electromagnetic pollution: It is time to assess its impact. *The Lancet Planetary Health*, *2*(12), e512–e514.

Belpomme, D., Hardell, L., Belyaev, I., Burgio, E., & Carpenter, D. O. (2018). Thermal and non-thermal health effects of low intensity non-ionizing radiation: An international perspective. *Environmental Pollution*, *242*, 643–658.

Carpenter DO. (2013) Human disease resulting from exposure to electromagnetic fields. Rev Environ Health.;28(4):159-72.

Davis, D., Sears, M. E., Miller, A. B., & Bray, R. (2017). Microwave/Radiofrequency Radiation and Human Health: Clinical Management in the Digital Age. In A. Cohen, F. S. vom Saal, & A. Weil (Eds.), *Integrative Environmental Medicine* (p. 0). Oxford University Press.

Davis, D., Birnbaum, L., Ben-Ishai, P., Taylor, H., Sears, M., Butler, T., & Scarato, T. (2023). Wireless technologies, non-ionizing electromagnetic fields and children: Identifying and reducing health risks. *Current Problems in Pediatric and Adolescent Health Care*, *53*(2), 101374.

Directorate-General for Parliamentary Research Services (European Parliament), & Belpoggi, F. (2021). Health impact of 5G: Current state of knowledge of 5G related carcinogenic and reproductive/developmental hazards as they emerge from epidemiological studies and in vivo experimental studies. Publications Office of the European Union.

International Commission on the Biological Effects of Electromagnetic Fields (ICBE-EMF), (2022). Scientific evidence invalidates health assumptions underlying the FCC and ICNIRP exposure limit determinations for radiofrequency radiation: implications for 5G. Environ Health. Oct 18;21(1):92.

Kocaman A, Altun G, Kaplan AA, Deniz ÖG, Yurt KK, Kaplan S. Genotoxic and carcinogenic effects of non-ionizing electromagnetic fields. Environ Res. 2018 May;163:71-79. doi: 10.1016/j.envres.2018.01.034. Epub 2018 Feb 22. PMID: 29427953.

Lai H, Levitt BB. (2023) Cellular and molecular effects of non-ionizing electromagnetic fields. Rev Environ Health.

López-Álvarez C, López-Martín ME, Rodríguez-González JA, Ares-Pena FJ. A Review on the Effects of Thermal Inversions and Electromagnetic Fields on Cell Cultures and Wireless Communications. Sensors (Basel). 2023 Dec 2;23(23):9567.

Martel J, Rouleau N, Murugan NJ, Chin WC, Ojcius DM, Young JD. Effects of light, electromagnetic fields and water on biological rhythms. Biomed J. 2024 Dec 11:100824. doi: 10.1016/j.bj.2024.100824. Epub ahead of print. PMID: 39672328.

McCredden, J. E., Cook, N., Weller, S., & Leach, V. (2022). Wireless technology is an environmental stressor requiring new understanding and approaches in health care. *Frontiers in Public Health*, *10*.

Miller, A. B., Sears, M. E., Morgan, L. L., Davis, D. L., Hardell, L., Oremus, M., & Soskolne, C. L. (2019). Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices. *Frontiers in Public Health*, *7*.

Miller, A. B., Morgan, L. L., Udasin, I., & Davis, D. L. (2018). Cancer epidemiology update, following the 2011 IARC evaluation of radiofrequency electromagnetic fields (Monograph 102). *Environmental Research*, *167*, 673–683.

Panagopoulos, D. J., Johansson, O., & Carlo, G. L. (2015). Polarization: A Key Difference between Man-made and Natural Electromagnetic Fields, in regard to Biological Activity. *Scientific Reports*, *5*, 14914.

Panagopoulos, D. J. (Ed.). (2022). *Electromagnetic Fields of Wireless Communications: Biological and Health Effects* (1st ed.). CRC Press.

Panagopoulos, D. J., Karabarbounis, A., Yakymenko, I., & Chrousos, G. P. (2021). Human-made electromagnetic fields: Ion forced-oscillation and voltage-gated ion channel dysfunction, oxidative stress and DNA damage (Review). International Journal of Oncology, 59(5), 92.

Panagopoulos DJ. Comparing DNA damage induced by mobile telephony and other types of man-made electromagnetic fields. Mutat Res Rev Mutat Res. 2019 Jul-Sep;781:53-62.

McCredden, J. E., Weller, S., & Leach, V. (2023). The assumption of safety is being used to justify the rollout of 5G technologies. *Frontiers in public health*, *11*, 1058454.

Ben Ishai P, Baldwin HZ, Birnbaum LS, Butler T, Chamberlin K, Davis DL, Scarato T, Taylor H (2024). Applying the Precautionary Principle to Wireless Technology: Policy Dilemmas and Systemic Risks. Environment: Science and Policy for Sustainable Development. 66:2, 5-18.

Miller, A. B., Sears, M. E., Morgan, L. L., Davis, D. L., Hardell, L., Oremus, M., & Soskolne, C. L. (2019). Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices. *Frontiers in Public Health*, *7*.

Benini M, Parazzini M, Bonato M, Gallucci S, Chiaramello E, Fiocchi S, Tognola G. Assessment of Children's Exposure to Intelligent Transport System 5.9 GHz Vehicular Connectivity Using Numerical Dosimetry. Sensors (Basel). 2023 May 29;23(11):5170. doi: 10.3390/s23115170. PMID: 37299897; PMCID: PMC10255686.

Stanković, V., Jovanović, D., Krstić, D., Markovic, V..., & Dunjic, M. (2017). Calculation of electromagnetic field from mobile phone induced in the pituitary gland of children head model. *Vojnosanitetski Pregled, 74*, 854-861.

Stankovic, Vladimir & Jovanovic, Dejan & Krstić, Dejan & Zigar, Darko & Malenović-Nikolić, Jelena. (2020). Distribution of the magnetic field from a mobile phone at 0.9, 1.8 and 2.1 GHz through a child head model. Safety Engineering. 10. 81-84. 10.5937/SE2002081S.

Vladimir STANKOVIĆ*, Dejan JOVANOVIĆ, Milan BLAGOJEVIĆ, Miomir RAOS, Anđela JEVTIĆ, Temperature Distribution and Specific Absorption Rate inside a Child's Eyes from Mobile Phone, Teh Vjesn 2023; 30 (2): 608-613

Turgut A, Engiz BK. Analyzing the SAR in Human Head Tissues under Different Exposure Scenarios. Applied Sciences. 2023; 13(12):6971. https://doi.org/10.3390/app13126971

C. Fernández-Rodríguez, G. Bulla and A. A. de Salles, "RF Exposure Due to Mobile Devices Operated Close to the Human Body." 2019 49th European Microwave Conference (EuMC), Paris, France, 2019, pp. 264-267, doi: 10.23919/EuMC.2019.8910925.
Assefa EM and Abdu SM (2025) Histopathologic effects of mobile phone radiation exposure on the testes and sperm parameters: a systematic literature review of animal studies. Front. Reprod. Health 6:1515166. doi: 10.3389/frph.2024.1515166

Chen, H.-G., Wu, P., Sun, B., Chen, J.-X., Xiong, C.-L., Meng, T.-Q., Huang, X.-Y., Su, Q.-L., Zhou, H., Wang, Y.-X., Ye, W., & Pan, A. (2022). Association between electronic device usage

and sperm quality parameters in healthy men screened as potential sperm donors. *Environmental Pollution (Barking, Essex: 1987)*, *312*, 120089.

Chu KY, Khodamoradi K, Dullea A, Ramasamy R. Swipe Right on Male Infertility: Effect of cell phone radiation on sperm motility. Fertility and Sterility. 118(5 Suppl):e38-e39. 2022.

Desai, N.R., Kesari, K.K. & Agarwal, A. Pathophysiology of cell phone radiation: oxidative stress and carcinogenesis with focus on male reproductive system. *Reprod Biol Endocrinol* 7, 114 (2009).

Dasdag, S., Muzaffer T., Mehmet Z.A., & Korkut Y., (2015) Effect of long-term exposure of 2.4 GHz radiofrequency radiation emitted from Wi-Fi equipment on testes functions, Electromagnetic Biology and Medicine, 34:1, 37-42

Esmailzadeh, S., Delavar, M. A., Aleyassin, A., Gholamian, S. A., & Ahmadi, A. (2019). Exposure to Electromagnetic Fields of High Voltage Overhead Power Lines and Female Infertility. *The International Journal of Occupational and Environmental Medicine*, *10*(1), 11–16.

Gautam R, Arora T. Radio Frequency Electromagnetic Radiation (RF-EMR) Emitted from Mobile Phone and its Impact on Male Reproductive Health. EIACP: Diversity and Impact on the Environment. 28(3):8-11. 2023.

Hassanzadeh-Taheri, M., Khalili, M. A., Hosseininejad Mohebati, A., Zardast, M., Hosseini, M., Palmerini, M. G., & Doostabadi, M. R. (2022). The detrimental effect of cell phone radiation on sperm biological characteristics in normozoospermic. *Andrologia*, *54*(1), e14257.

Houston, B. J., Nixon, B., King, B. V., De Iuliis, G. N., & Aitken, R. J. (2016). The effects of radiofrequency electromagnetic radiation on sperm function. *Reproduction (Cambridge, England)*, *152*(6), R263–R276.

Phillips, J. L., Singh, N. P., & Lai, H. (2009). Electromagnetic fields and DNA damage. *Pathophysiology: The Official Journal of the International Society for Pathophysiology*, *16*(2–3), 79–88.

Ruediger, H. W. (2009). Genotoxic effects of radiofrequency electromagnetic fields. *Pathophysiology: The Official Journal of the International Society for Pathophysiology*, *16*(2–3), 89–102.

Smith-Roe, S. L., Wyde, M. E., Stout, M. D., Winters, J. W., Hobbs, C. A., Shepard, K. G., Green, A. S., Kissling, G. E., Shockley, K. R., Tice, R. R., Bucher, J. R., & Witt, K. L. (2020). Evaluation of the genotoxicity of cell phone radiofrequency radiation in male and female rats and mice following subchronic exposure. *Environmental and Molecular Mutagenesis*, *61*(2), 276–290.

Weller, S., Leach, V., & May, M. (2023). *Genotoxic Potential of Radiofrequency Exposures.*

Appendix 2: Substantial scientific research indicates serious wildlife and environmental impacts of unfettered wireless proliferation. Here are some examples.

Jérémy S. P. Froidevaux, Laura Recuero Virto, Marek Czerwiński, Arno Thielens, and Kirsty J. Park Addressing Wildlife Exposure to Radiofrequency Electromagnetic Fields: Time for Action Environmental Science & Technology Letters, 2024, 11, 1, 3−4

Balmori A. (2024) Radio-tracking systems emit pulsed waves that could affect the health and alter the orientation of animals. Journal for Nature Conservation Volume 77, January

Balmori A. (2021) Electromagnetic radiation as an emerging driver factor for the decline of insects. Science of the Total Environment. 767: 144913

Balmori, A. (2015). Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation. Science of The Total Environment, 518–519, 58–60.

Balmori A. (2014). Electrosmog and species conservation. Science of The Total Environment, 496:314-316

Balmori A. Radiotelemetry and wildlife: Highlighting a gap in the knowledge on radiofrequency radiation effects. Sci Total Environ. 2016 Feb 1;543

Balmori A. Electromagnetic pollution from phone masts. Effects on wildlife. Pathophysiology. 2009 Aug;16(2-3):191-9

Balmori, A. The incidence of electromagnetic pollution on wild mammals: A new “poison” with a slow effect on nature?. Environmentalist 30, 90–97 (2010).

Cucurachi, S., Tamis, W. L. M., Vijver, M. G., Peijnenburg, W. J. G. M., Bolte, J. F. B., & de Snoo, G. R. (2013). A review of the ecological effects of radiofrequency electromagnetic fields (RF-EMF). Environment International, 51, 116–140.

Froidevaux JSP, Recuero Virto L, Czerwiński M, Thielens A, Park KJ. 2024. Addressing Wildlife Exposure to Radiofrequency Electromagnetic Fields: Time for Action. Environ Sci Technol Lett. 11(1):3–4. https://doi.org/10.1021/acs.estlett.3c00795

Klune J, Arhant C, Windschnurer I, Heizmann V, Schauberger G. Tracking Devices for Pets: Health Risk Assessment for Exposure to Radiofrequency Electromagnetic Fields. *Animals*. 2021; 11(9):2721. https://doi.org/10.3390/ani11092721

Cammaerts, Marie-Claire. “Is electromagnetism one of the causes of the CCD? A work plan for testing this hypothesis.” *Journal of Behavior* 2.1 (2017): 1006.

Thill A, Cammaerts MC, Balmori A. Biological effects of electromagnetic fields on insects: a systematic review and meta-analysis. Rev Environ Health. 2023 Nov 23

Levitt BB, Lai HC and Manville AM II (2022) Low-level EMF effects on wildlife and plants: What research tells us about an ecosystem approach. Front. Public Health 10:1000840. doi: 10.3389/fpubh.2022.1000840

Levitt, B. B., Lai, H. C., & Manville, A. M. (2021a). Effects of non-ionizing electromagnetic fields on flora and fauna, part 1. Rising ambient EMF levels in the environment. Reviews on Environmental Health, 37(1), 81–122.

Levitt, B. B., Lai, H. C., & Manville, A. M. (2021b). Effects of non-ionizing electromagnetic fields on flora and fauna, Part 2 impacts: How species interact with natural and man-made EMF. Reviews on Environmental Health, 37(3), 327–406.

Levitt, B. B., Lai, H. C., & Manville, A. M. (2021c). Effects of non-ionizing electromagnetic fields on flora and fauna, Part 3. Exposure standards, public policy, laws, and future directions. Reviews on Environmental Health.

Manville AM II, Levitt BB and Lai HC (2024) Health and environmental effects to wildlife from radio telemetry and tracking devices—state of the science and best management practices. Front. Vet. Sci. 11:1283709.

Panda DK, Das DP, Behera SK, Dhal NK. Review on the impact of cell phone radiation effects on green plants. Environ Monit Assess. 2024 May 21;196(6):565

Panagopoulos DJ, Karabarbounis A, Chrousos GP. Biophysical mechanism of animal magnetoreception, orientation and navigation. Sci Rep. 2024 Dec 3;14(1):30053. doi: 10.1038/s41598-024-77883-9. PMID: 39627252; PMCID: PMC11615392.

Sivani, S, and D. Sudarsanam. (2012): "Impacts of radio-frequency electromagnetic field (RF-EMF) from cell phone towers and wireless devices on biosystem and ecosystem-a review." Biology and Medicine 4, no. 4 202-216.

Recuero Virto L, Thielens A, Czerwiński M, Froidevaux J. The exposure of nonhuman living organisms to mobile communication emissions: A survey to establish European stakeholders' policy option preferences. Risk Anal. 2024 May 22.

Zhen C, Zhang G, Wang S, Wang J, Fang Y, Shang P. Electromagnetic fields regulate iron metabolism in living organisms: A review of effects and mechanism. Prog Biophys Mol Biol. 2024 Mar 4;188:43-54.

BIRDS

Luo J, Benjamin P, Gerhards L, Hogben HJ, Hore PJ. Orientation of birds in radiofrequency fields in the absence of the Earth's magnetic field: a possible test for the radical pair mechanism of magnetoreception. J R Soc Interface. 2024 Aug;21(217):20240133. doi: 10.1098/rsif.2024.0133.

Augustianath, T., Evans, D. A., & Anisha, G. S. (2023). Teratogenic effects of radiofrequency electromagnetic radiation on the embryonic development of chick: A study on morphology and hatchability. Research in veterinary science, 159, 93–100.

Deena K, Maadurshni GB, Manivannan J, Sivasamy R. Short-term exposure of 2.4 GHz electromagnetic radiation on cellular ROS generation and apoptosis in SH-SY5Y cell line and impact on developing chick embryo brain tissue. Mol Biol Rep. 2025 Jan 21;52(1):144. doi: 10.1007/s11033-025-10217-8. PMID: 39836269.

Balmori A. (2022). Corneal opacity in Northern Bald Ibises (Geronticus eremita) equipped with radio transmitters. Electromagnetic Biol Med.174-176.

Alfonso Balmori (2005) Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork (Ciconia ciconia), Electromagnetic Biology and Medicine, 24:2, 109-119

Balmori A, Hallberg O. The urban decline of the house sparrow (Passer domesticus): a possible link with electromagnetic radiation. Electromagn Biol Med. 2007;26(2):141-51.

Engels, S.; Schneider, N.L.; Lefeldt, N.; Hein, C.M.; Zapka, M.; Michalik, A.; Elbers, D.; Kittel, A.; Hore, P.J.; Mouritsen, H. Anthropogenic electromagnetic noise disrupts magnetic compass orientation in a migratory bird. Nature 2014, 509, 353–356.

Everaert, J.; Bauwens, D. A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrows (Passer domesticus). Electromagn. Biol. Med.2007, 26, 63–72.

Islam, M. S., Islam, M. M., Rahman, M. M., & Islam, K. (2023). 4G mobile phone radiation alters some immunogenic and vascular gene expressions, and gross and microscopic and biochemical parameters in the chick embryo model. Veterinary medicine and science, 10.1002/vms3.1273. Advance online publication.

Leberecht, B., Wong, S. Y., Satish, B., Döge, S., Hindman, J., Venkatraman, L., Apte, S., Haase, K., Musielak, I., Dautaj, G., Solov'yov, I. A., Winklhofer, M., Mouritsen, H., & Hore, P. J. (2023). Upper bound for broadband radiofrequency field disruption of magnetic compass orientation in

night-migratory songbirds. Proceedings of the National Academy of Sciences of the United States of America, 120(28), e2301153120.

Fernie, K. J., & Reynolds, S. J. (2005). The effects of electromagnetic fields from power lines on avian reproductive biology and physiology: A review. Journal of Toxicology and Environmental Health. Part B, Critical Reviews, 8(2), 127–140.

Fernie, K.J.; Bird, D.M. Evidence of oxidative stress in American kestrels exposed to electromagnetic fields. Environ. Res. A 2001, 86, 198–207.

Muheim, R., & Phillips, J. B. (2023). Effects of low-level RF fields reveal complex pattern of magnetic input to the avian magnetic compass. Scientific reports, 13(1), 19970.

Sakraoui D, Ziane N, Ghalem R, Boukheroufa M, Habbachi W (2023): Is there an effect of electromagnetic waves from base stations on the breeding success of Ciconia ciconia in Algeria? Biosystems Diversity. 2023 Nov 7;31(4):493-9. https://doi.org/10.15421/012358'

Schwarze, S., Schneider, N.-L., Reichl, T., Dreyer, D., Lefeldt, N., Engels, S., Baker, N., Hore, P. J., & Mouritsen, H. (2016). Weak Broadband Electromagnetic Fields are More Disruptive to Magnetic Compass Orientation in a Night-Migratory Songbird (Erithacus rubecula) than Strong Narrow-Band Fields. Frontiers in Behavioral Neuroscience, 10.

Sheridan, E.; Randolet, J.; DeVault, T.L.; Seamans, T.W.; Blackwell, B.F.; Fernández-Juricic, E. The effects of radar on avian behavior: Implications for wildlife management at airports. Appl. Anim. Behav. Sci. 2015, 171, 241–252.

Shende, V.A.; Patil, K.G. Electromagnetic radiations: A possible impact on population of house sparrow (Passer Domesticus). Eng. Int. 2015, 3, 45–52.

Surendran, N.S.; Siddiqui, N.A.; Mondal, P.; Nandan, A. Repercussion of electromagnetic radiation from cell towers/mobiles and their impact on migratory birds. In Advances in Air Pollution Profiling and Control; Springer: Singapore, 2020; pp. 193–202.

Tonelli, B. A., Youngflesh, C., & Tingley, M. W. (2023). Geomagnetic disturbance associated with increased vagrancy in migratory landbirds. Scientific Reports, 13(1), Article 1.

Wiltschko, R., Thalau, P., Gehring, D., Nießner, C., Ritz, T., & Wiltschko, W. (2015). Magnetoreception in birds: The effect of radio-frequency fields. Journal of The Royal Society Interface, 12(103), 20141103.

Singh, G., Rana, A. Honeybees and colony collapse disorder: understanding key drivers and economic implications. Proc.Indian Natl. Sci. Acad. (2025). https://doi.org/10.1007/s43538-025-00399-x

Herssens, H., Toribio, D., De Borre, E., & Thielens, A. (2022). Whole-Body Averaged Absorbed Power in Insects Exposed to Far-Field Radio Frequency Electromagnetic Fields. IEEE Transactions on Antennas and Propagation, 70, 11070-11078.

As, N., Karan, Y., Dizman, S., Sayi, B. C., Kuvanci, A., Cinbirtoğlu, Ş., … Şahin, M. E. (2024). An experimental study on the effect of non-ionizing electromagnetic fields on honey bees. Electromagnetic Biology and Medicine, 1–14. https://doi.org/10.1080/15368378.2024.2445109

Jobe NB, Chourasia A, Smith BH, Molins E, Rose A, Pavlic TP, Paaijmans KP. Using electric fields to control insects: current applications and future directions. J Insect Sci. 2024 Jan 1;24(1):8. doi: 10.1093/jisesa/ieae007. PMID: 38340047; PMCID: PMC10858648.

Harst, W., Kuhn, J., Stever, H. (2007) Can electromagnetic exposure cause a change in behavior? Studying possible non-thermal influences on honey bees – An approach within the framework of Educational Informatics, ACTA SYSTEMICA - IIAS International Journal, 2006, Vol. VI, No. 1, pp. 1-6

El-Gashingy, D., Meshrif, W., Mansour, D., Naiem, E., & Seif, A. (2024). Effect of the electric field generated from high voltage power lines on the biology and behavior of the fruit fly, Drosophila melanogaster. Catrina: The International Journal of Environmental Sciences, 30(1), 51-63

Vilić, Marinko, Ivona Žura Žaja, Mirta Tkalec, Perica Tucak, Krešimir Malarić, Nato Popara, Nikolino Žura, Selim Pašić, and Ivana Tlak Gajger. 2024. "Oxidative Stress Response of Honey Bee Colonies (Apis mellifera L.) during Long-Term Exposure at a Frequency of 900 MHz under Field Conditions" Insects 15, no. 5: 372. https://doi.org/10.3390/insects15050372

Tlak Gajger, I.; Vilić, M.; Tucak, P.; Malarić, K. Effect of Electromagnetic Field on Some Behaviour Modality of Honeybee Colonies (Apis mellifera) in Field Conditions. J. Anim. Vet. Adv. 2001, 18, 61–64. ‘

A. Lázaro, A. Chroni, T. Tscheulin, J. Devalez, C. Matsoukas, & T. Petanidou. (2016). Electromagnetic radiation of mobile telecommunication antennas affects the abundance and composition of wild pollinators. Journal of Insect Conservation, 20(2), 315–324. https://doi.org/10.1007/s10841-016-9868-8

Adelaja, O. J., Ande, A. T., Abdulraheem, G. D., Oluwakorode, I. A., Oladipo, O. A., & Oluwajobi, A. O. (2021). Distribution, diversity and abundance of some insects around a telecommunication mast in Ilorin, Kwara State, Nigeria. Bulletin of the National Research Centre, 45(1), 222.

Balmori A. (2021) Electromagnetic radiation as an emerging driver factor for the decline of insects. Science of the Total Environment. 767: 144913

Borre, E. D., Joseph, W., Aminzadeh, R., Müller, P., Boone, M. N., Josipovic, I., Hashemizadeh, S., Kuster, N., Kühn, S., & Thielens, A. (2021). Radio-frequency exposure of the yellow fever mosquito (A. aegypti) from 2 to 240 GHz. PLOS Computational Biology, 17(10), e1009460.

Cappucci, Ugo, Assunta Maria Casale, Mirena Proietti, Fiorenzo Marinelli, Livio Giuliani, and Lucia Piacentini. 2022. Wi-Fi Related Radiofrequency Electromagnetic Fields Promote Transposable Element Dysregulation and Genomic Instability in Drosophila melanogaster, Cells 11, no. 24: 4036. https://doi.org/10.3390/cells11244036

D. Toribio and A. Thielens, "Radio Frequency Electromagnetic Field Exposure of Insects at 10 cm from an Antenna," in IEEE Antennas and Wireless Propagation Letters, doi: 10.1109/LAWP.2024.3501977. keywords: {Radio frequency electromagnetic field exposure;insects;dipole antenna;millimeter waves},

De Paepe S, De Borre E, Toribio Carvajal D, Bell D, Thielens A. (2022) Pilot study of a new methodology to study the development of the blue bottle fly (Calliphora vomitoria) under exposure to radio-frequency electromagnetic fields at 5.4 GHz. Int J Radiat Biol. Aug 24:1-17

Thill A, Cammaerts MC, Balmori A. Biological effects of electromagnetic fields on insects: a systematic review and meta-analysis. Rev Environ Health. 2023 Nov 23

Favre, D. (2011). Mobile phone-induced honeybee worker piping. Apidologie, 42(3), 270–279.

Fedele, G., Edwards, M. D., Bhutani, S., Hares, J. M., Murbach, M., Green, E. W., Dissel, S., Hastings, M. H., Rosato, E., & Kyriacou, C. P. (2014). Genetic analysis of circadian responses to low frequency electromagnetic fields in Drosophila melanogaster. PLoS Genetics, 10(12), e1004804.

V. Jeladze, A. Thielens, T. Nozadze, G. Korkotadze, B. Partsvania and R. Zaridze, "Estimation of the Specific Absorption Rate for a Honey bee Exposed to Radiofrequency Electromagnetic Fields from 2.5 to 100 GHz," 2023 IEEE XXVIII International Seminar/Workshop on Direct and Inverse Problems of Electromagnetic and Acoustic Wave Theory (DIPED), Tbilisi, Georgia, 2023, pp. 180-185

Jeladze V, Nozadze T, Partsvania B, Thielens A, Shoshiashvili L, Gogoladze T. Numerical dosimetry of specific absorption rate of insects exposed to far-field radiofrequency electromagnetic fields. Int J Radiat Biol. 2025 Jan 2:1-14. doi: 10.1080/09553002.2024.2442693.

Lupi D, Palamara Mesiano M, Adani A, Benocci R, Giacchini R, Parenti P, Zambon G, Lavazza A, Boniotti MB, Bassi S, et al. Combined Effects of Pesticides and Electromagnetic-Fields on Honeybees: Multi-Stress Exposure. Insects. 2021; 12(8):716. https://doi.org/10.3390/insects12080716

Kumar NR, Sangwan S, Badotra P. Exposure to cell phone radiations produces biochemical changes in worker honey bees. Toxicol Int. 2011 Jan;18(1):70-2. doi: 10.4103/0971-6580.75869. PMID: 21430927; PMCID: PMC3052591.

Koziorowska A, Depciuch J, Białek J, Woś I, Kozioł K, Sadło S, Piechowicz B. Electromagnetic field of extremely low frequency has an impact on selected chemical components of the honeybee. Pol J Vet Sci. 2020 Dec;23(4):537-544.

Lee, K.-S., Choi, J.-S., Hong, S.-Y., Son, T.-H., & Yu, K. (2008). Mobile phone electromagnetic radiation activates MAPK signaling and regulates viability in Drosophila. Bioelectromagnetics, 29(5), 371–379.

Li Y, Sun C, Zhou H, Huang H, Chen Y, Duan X, Huang S, Li J. Extremely Low-Frequency Electromagnetic Field Impairs the Development of Honeybee (Apis cerana). Animals (Basel). 2022 Sep 14;12(18):2420. doi: 10.3390/ani12182420. PMID: 36139284; PMCID: PMC9495099.

Li, S.-S., Zhang, Z.-Y., Yang, C.-J., Lian, H.-Y., & Cai, P. (2013). Gene expression and reproductive abilities of male Drosophila melanogaster subjected to ELF-EMF exposure. Mutation Research. Genetic Toxicology and Environmental Mutagenesis, 758(1–2), 95–103.

Lopatina, N. G., Zachepilo, T. G., Kamyshev, N. G., Dyuzhikova, N. A., & Serov, I. N. (2019). Effect of Non-Ionizing Electromagnetic Radiation on Behavior of the Honeybee, Apis mellifera L. (Hymenoptera, Apidae). Entomological Review, 99(1), 24–29.

Lupi, D., Tremolada, P., Colombo, M., Zambon, G., & Vighi, M. (2020). Effects of Pesticides 23 and Electromagnetic Fields on Honeybees: A Field Study Using Biomarkers. Int J Environ Res 24 14, 107–122.

Lupi, D., Palamara Mesiano, M., Adani, A., Benocci, R., Giacchini, R., Parenti, P., Zambon, G., Lavazza, A., Boniotti, M. B., Bassi, S., Colombo, M., & Tremolada, P. (2021a). Combined Effects of Pesticides and Electromagnetic-Fields on Honeybees: Multi-Stress Exposure. Insects, 12(8), 716.

Manta, A. K., Papadopoulou, D., Polyzos, A. P., Fragopoulou, A. F., Skouroliakou, A. S., Thanos, D., Stravopodis, D. J., & Margaritis, L. H. (2017). Mobile-phone radiation-induced perturbation of gene-expression profiling, redox equilibrium and sporadic-apoptosis control in the ovary of Drosophila melanogaster. Fly, 11(2), 75–95.

Mahmoud EA and Gabarty A (2021) "Impact of Electromagnetic Radiation on Honey Stomach Ultrastructure and the Body Chemical Element Composition of Apis mellifera," African Entomology 29(1), 32-41, (23 March).

Molina-Montenegro MA, Acuña-Rodríguez IS, Ballesteros GI, Baldelomar M, Torres-Díaz C, Broitman BR, Vázquez DP. (2023) Electromagnetic fields disrupt the pollination service by honeybees. Sci Adv. May 12;9(19)

Manuel Reategui-Inga, Eli Morales Rojas, Daniel Tineo, Marcelino Jorge Araníbar-Araníbar, Wilfredo Alva Valdiviezo, Casiano Aguirre Escalante and Sandro Junior Ruiz Castre, 2023. Effects of Artificial Electromagnetic Fields on Bees: A Global Review. Pakistan Journal of Biological Sciences, 26: 23-32.

Migdał P, Murawska A, Strachecka A, Bieńkowski P, Roman A. Honey Bee Proteolytic System and Behavior Parameters under the Influence of an Electric Field at 50 Hz and Variable Intensities for a Long Exposure Time. Animals (Basel). 2021 Mar 18;11(3):863. doi: 10.3390/ani11030863. PMID: 33803600; PMCID: PMC8003097

Migdał, P., Berbeć, E., Bieńkowski, P., Plotnik, M., Murawska, A., & Latarowski, K. (2022b). Exposure to Magnetic Fields Changes the Behavioral Pattern in Honeybees (Apis mellifera L.) under Laboratory Conditions. Animals: An Open Access Journal from MDPI, 12(7), 855.

Migdal, P., Bieńkowski, P., Cebrat, M., Berbeć, E., Plotnik, M., Murawska, A., Sobkiewicz, P., Łaszkiewicz, A., & Latarowski, K. (2023). Exposure to a 900 MHz electromagnetic field induces a response of the honey bee organism on the level of enzyme activity and the expression of stress-related genes. PloS one, 18(5), e0285522.

Migdał P, Murawska A, Strachecka A, Bieńkowski P, Roman A. Changes in the Honeybee Antioxidant System after 12 h of Exposure to Electromagnetic Field Frequency of 50 Hz and Variable Intensity. Insects. 2020 Oct 18;11(10):713. doi: 10.3390/insects11100713. PMID: 33081029; PMCID: PMC7603132.

Migdał P, Murawska A, Bieńkowski P, Strachecka A, Roman A. Effect of the electric field at 50 Hz and variable intensities on biochemical markers in the honey bee's hemolymph. PLoS One. 2021 Jun 24;16(6):e0252858.

Migdał P, Murawska A, Bieńkowski P, Berbeć E, Roman A. Changes in Honeybee Behavior Parameters under the Influence of the E-Field at 50 Hz and Variable Intensity. Animals (Basel). 2021 Jan 20;11(2):247. doi: 10.3390/ani11020247. PMID: 33498413; PMCID: PMC7909437.

Migdal, P., Plotnik, M., Bieńkowski, P., Murawska, A., Berbeć, E., Sobkiewicz, P., … Latarowski, K. (2024). Changes in honey bee nutrition after exposure to radiofrequency electromagnetic field. The European Zoological Journal, 91(1), 172–179. https://doi.org/10.1080/24750263.2024.2308550

Murawska A, Migdał P, Mating M, Bieńkowski P, Berbeć E, Einspanier R. Metabolism gene expression in worker honey bees after exposure to 50Hz electric field - semi-field analysis. Front

Zool. 2024 May 29;21(1):14. doi: 10.1186/s12983-024-00535-1. PMID: 38807222; PMCID: PMC11134740.

Nashaat El Halabi, Roger Achkar, Gaby Abou Haidar, "The effect of cell phone antennas' radiations on the life cycle of honeybees", MELECON 2014 - 2014 17th IEEE Mediterranean Electrotechnical Conference, pp.408-414, 2014.

Nikita, Grover, A., Kalia, P., Sinha, R., & Garg, P. (2022). Colony collapse disorder: A peril to apiculture. Journal of Applied and Natural Science, 14(3), 729–739. https://doi.org/10.31018/jans.v14i3.3502

Nik Abdull Halim NMH, Mohd Jamili AF, Che Dom N, Abd Rahman NH, Jamal Kareem Z, Dapari R. The impact of radiofrequency exposure on Aedes aegypti (Diptera: Culicidae) development. PLoS One. 2024 Feb 27;19(2):e0298738.

Odemer, R., & Odemer, F. (2019). Effects of radiofrequency electromagnetic radiation (RF-EMF) on honey bee queen development and mating success. Science of The Total Environment, 661, 553–562.

Panagopoulos DJ. Effect of microwave exposure on the ovarian development of Drosophila melanogaster. Cell Biochem Biophys. 2012 Jun;63(2):121-32.

Panagopoulos DJ, Karabarbounis A, Lioliousis C. ELF alternating magnetic field decreases reproduction by DNA damage induction. Cell Biochem Biophys. 2013 Nov;67(2):703-16. doi: 10.1007/s12013-013-9560-5. PMID: 23526156.

Piechowicz B, Sadło S, Woś I, Białek J, Depciuch J, Podbielska M, Szpyrka E, Kozioł K, Piechowicz I, Koziorowska A. Treating honey bees with an extremely low frequency electromagnetic field and pesticides: Impact on the rate of disappearance of azoxystrobin and λ-cyhalothrin and the structure of some functional groups of the probabilistic molecules. Environ Res. 2020 Nov;190:109989

Dimitris J. Panagopoulos, Andreas Karabarbounis & Lukas H. Margaritis (2004) Effect of GSM 900-MHz Mobile Phone Radiation on the Reproductive Capacity of Drosophila melanogaster, Electromagnetic Biology and Medicine, 23:1, 29-43

Santhosh Kumar, S. (2018). Colony Collapse Disorder (CCD) in Honey BeesCaused by EMF Radiation. Bioinformation, 14(9), 421–424.

Singh, G., Rana, A. Honeybees and colony collapse disorder: understanding key drivers and economic implications. Proc.Indian Natl. Sci. Acad. (2025). https://doi.org/10.1007/s43538-025-00399-x

Sharma, V.P. and N.K. Kumar. “Changes in honeybee behaviour and biology under the influence of cellphone radiations.” Current Science 98.10 (2010): 1376-8.

Shepherd S, Lima MAP, Oliveira EE, Sharkh SM, Jackson CW, Newland PL. Extremely Low Frequency Electromagnetic Fields impair the Cognitive and Motor Abilities of Honey Bees. Sci Rep. 2018 May 21;8(1):7932.

L. Szychta, E. Szychta and K. Olszewski, "The Influence of Electromagnetic Field on Honey Bee Workers – Review Paper," 2024 ELEKTRO (ELEKTRO), Zakopane, Poland, 2024, pp. 1-5,

R.R. Taye, M.K. Deka, A. Rahman and M. Bathari, "Effect of electromagnetic radiation of cellphone tower on foraging behavior of Asiatic honeybee", Journal of Entomology and Zoology Studies, vol. 5, no. 3, pp. 1527-1529, 2017

Thielens, A., Bell, D., Mortimore, D. B., Greco, M. K., Martens, L., & Joseph, W. (2018). Exposure of Insects to Radio-Frequency Electromagnetic Fields from 2 to 120 GHz. Scientific Reports, 8(1), 3924.

Thielens A, Greco MK, Verloock L, Martens L, Joseph W. Radio-Frequency Electromagnetic Field Exposure of Western Honey Bees. Scientific Reports. 2020 Jan 16;10(1):461.

Treder M, Müller M, Fellner L, Traynor K, Rosenkranz P. Defined exposure of honey bee colonies to simulated radiofrequency electromagnetic fields (RF-EMF): Negative effects on the homing ability, but not on brood development or longevity. Sci Total Environ. 2023 Oct 20;896:165211.

Wang, Y., Jiang, Z., Zhang, L., Zhang, Z., Liao, Y., & Cai, P. (2022b). 3.5-GHz radiofrequency electromagnetic radiation promotes the development of Drosophila melanogaster. Environmental Pollution (Barking, Essex: 1987), 294, 118646.

Wang, Y., Zhang, H., Zhang, Z., Sun, B., Tang, C., Zhang, L., Jiang, Z., Ding, B., Liao, Y., & Cai, P. (2021). Simulated mobile communication frequencies (3.5 GHz) emitted by a signal generator affects the sleep of Drosophila melanogaster. Environmental Pollution (Barking, Essex: 1987), 283, 117087.

Wyszkowska J, Maliszewska J, Gas P. Metabolic and Developmental Changes in Insects as Stress-Related Response to Electromagnetic Field Exposure. Applied Sciences. 2023; 13(17):9893.

Wyszkowska J, Kobak J, Aonuma H. (2023). Electromagnetic field exposure affects the calling song, phonotaxis, and level of biogenic amines in crickets. Environ Sci Pollut Res Int.

PLANTS

Aikaterina L. Stefi, Dido Vassilacopoulou, Lukas H. Margaritis, Nikolaos S. Christodoulakis, (2018) Oxidative stress and an animal neurotransmitter synthesizing enzyme in the leaves of wild growing myrtle after exposure to GSM radiation, June

Valdis Balodis, Guntis Brūmelis, Kārlis Kalviškis, Oļģerts Nikodemus ,Didzis Tjarve,Vija Znotiņa, (1996) Does the Skrunda Radio Location Station diminish the radial growth of pine trees? Science of The Total Environment

Abdelhaliem, E., Abdalla, H. M., Bolbol, A. A., & Shehata, R. S. (2023). Assessment of protein and DNA polymorphisms in corn (Zea mays) under the effect of non-ionizing electromagnetic radiation. Caryologia, 75(4).

Halgamuge, M. N., & Davis, D. (2019). Lessons learned from the application of machine learning to studies on plant response to radio-frequency. Environmental research, 178, 108634.

Halgamuge, M. N. (2017). Review: Weak radiofrequency radiation exposure from mobile phone radiation on plants. Electromagnetic Biology and Medicine, 36(2), 213–235.

Halgamuge, M. N., Yak, S. K., & Eberhardt, J. L. (2015). Reduced growth of soybean seedlings after exposure to weak microwave radiation from GSM 900 mobile phone and base station. Bioelectromagnetics, 36(2), 87–95.

Handa AP, Vian A, Singh HP, Kohli RK, Kaur S, Batish DR. Effect of 2850 MHz electromagnetic field radiation on the early growth, antioxidant activity, and secondary metabolite profile of red and green cabbage (Brassica oleracea L.). Environ Sci Pollut Res Int. 2023 Dec 30.

Haggerty, K. (2010). Adverse Influence of Radio Frequency Background on Trembling Aspen Seedlings: Preliminary Observations. International Journal of Forestry Research, 836278.

Kaur, S., Vian, A., Chandel, S., Singh, D. H., Batish, D., & Kohli, R. (2021). Sensitivity of plants to high frequency electromagnetic radiation: Cellular mechanisms and morphological changes. Reviews in Environmental Science and Bio/Technology, 20.

Marek Czerwiński, Alain Vian, Ben A. Woodcock, Piotr Goliński, Laura Recuero Virto, Łukasz Januszkiewicz. (2023). Do electromagnetic fields used in telecommunications affect wild plant species? A control impact study conducted in the field. Ecological Indicators. Volume 150. 110267.

Panda DK, Das DP, Behera SK, Dhal NK. Review on the impact of cell phone radiation effects on green plants. Environ Monit Assess. 2024 May 21;196(6):565

Senavirathna MDHJ, Maimaiti Z. Assessing the biochemical and genotoxic effects of low intensity 2.45GHz microwave exposure on *Arabidopsis thaliana* plants. Electromagn Biol Med. 2024 Oct 3:1-9. doi: 10.1080/15368378.2024.2411629. Epub ahead of print. PMID: 39361824.

Sharma S, Sharma P, Singh J, Bahel S, Dutta R, Vig AP, Katnoria JK. Assessing cell viability and genotoxicity in Trigonella foenum-graecum L. exposed to 2100 MHz and 2300 MHz electromagnetic field radiations. Plant Physiol Biochem. 2024 Nov 19;219:109311. doi: 10.1016/j.plaphy.2024.109311.

Sharma A, Sharma S, Bahel S, Katnoria JK. A study on effects of cell phone tower-emitted non-ionizing radiations in an Allium cepa test system. Environ Monit Assess. 2024 Feb 13;196(3):261. doi: 10.1007/s10661-024-12435-2. PMID: 38349609.

Assessing Cell Viability and Genotoxicity in Trigonella foenum-graecum L. Exposed to 2100 MHz and 2300 MHz Electromagnetic Field Radiations - ScienceDirect

Sharma, S., Sharma, P., Bahel, S. et al. Comprehensive analysis of genotoxic effects and antioxidative defence mechanisms in plant test system exposed to 1800 MHz electromagnetic radiations: a root chromosomal aberration and FTIR spectroscopy approach. Toxicol. Environ. Health Sci. (2023).

Soran, M.-L., Stan, M., Niinemets, Ü., & Copolovici, L. (2014). Influence of microwave frequency electromagnetic radiation on terpene emission and content in aromatic plants. Journal of Plant Physiology, 171(15), 1436–1443.

Stefi, A. L., Margaritis, L. H., & Christodoulakis, N. S. (2016). The effect of the non ionizing radiation on cultivated plants of Arabidopsis thaliana (Col.). Flora, 223, 114–120.

Stefi, A.L., Mitsigiorgi, K., Vassilacopoulou, D. *et al.* Response of young *Nerium oleander* plants to long-term non-ionizing radiation. *Planta* **251**, 108 (2020).

Tran, N. T., Jokic, L., Keller, J., Geier, J. U., & Kaldenhoff, R. (2023). Impacts of Radio-Frequency Electromagnetic Field (RF-EMF) on Lettuce (Lactuca sativa)-Evidence for RF-EMF Interference with Plant Stress Responses. Plants (Basel, Switzerland), 12(5), 1082.

Waldmann-Selsam, C., Balmori-de la Puente, A., Breunig, H., & Balmori, A. (2016). Radiofrequency radiation injures trees around mobile phone base stations. Science of The Total Environment, 572, 554–569.

Marek Czerwiński, Łukasz Januszkiewicz, Alain Vian, Amparo Lázaro, (2020) The influence of bioactive mobile telephony radiation at the level of a plant community – Possible mechanisms and indicators of the effects, Ecological Indicators, Volume 108

Vian A, Davies E, Gendraud M, Bonnet P. Plant Responses to High Frequency Electromagnetic Fields. Biomed Res Int. 2016;2016

Zhong, Z., Wang, X., Yin, X., Tian, J., & Komatsu, S. (2021). Morphophysiological and Proteomic Responses on Plants of Irradiation with Electromagnetic Waves. International Journal of Molecular Sciences, 22(22), Article 22.

S. Pustake, V. Upadhyaya and M. Bundele, "Study and Analysis of 4G-5G Spectrum Mobile Signals on Germination Seed and Further Growth," 2022 IEEE Pune Section International Conference (PuneCon), Pune, India, 2022, pp. 1-7

Sharma, S., Sharma, P., Bahel, S. et al. Comprehensive analysis of genotoxic effects and antioxidative defence mechanisms in plant test system exposed to 1800 MHz electromagnetic radiations: a root chromosomal aberration and FTIR spectroscopy approach Toxicol. Environ. Health Sci. (2023).

A.L. Stefi, L.H. Margaritis, N.S. Christodoulakis (2017) The aftermath of long-term exposure to non-ionizing radiation on laboratory cultivated pine plants (Pinus halepensis M.) Flora, 234, pp. 173-186,

Ozel, HB, Cetin, M., Sevik, H., Varol, T., Isik, B., & Yaman, B. (2021). The effects of base station as an electromagnetic radiation source on flower and cone yield and germination percentage in Pinus brutia Ten. Biologia Futura , 72 (3), 359-365.

Pesnya DS, Romanovsky AV. Comparison of cytotoxic and genotoxic effects of plutonium-239 alpha particles and mobile phone GSM 900 radiation in the Allium cepa test. Mutat Res. 2013 Jan 20;750(1-2):27-33.

Pall. M., Electromagnetic Fields Act Similarly in Plants as in Animals: Probable Activation of Calcium Channels via Their Voltage Sensor, Current Chemical Biology, 2016, 10, 74-82

Appendix 3: Theodora Scarato Submissions of scientific research and policy reports that support this comment.

Theodora Scarato submitted copious documentation and evidence on the FCC docket of scientific research that has found adverse biological effects at nn thermal levels. These submissions support the EHS comment.

Below are the titles of the PDFs Scarato submitted and **all of these PDFS submitted** should be considered as part of this comment.

EFFECTS OF 900 MHz ELECTROMAGNETIC FIELDS EMITTED FROM A CELLULAR PHONE ON THE T3, T4, AND CORTISOL LEVELS IN SYRIAN HAMSTERS .pdf, High Frequency Hearing Loss Amongst Smart Mobile Phone Users A Case-Control Study.pdf, Effects of 5 G mobile phone network electromagnetic field exposure on testicular endoplasmic reticulum stress and the protective role of coenzyme Q10 - ScienceDirect.pdf, Delayed Growth in Immature Male Rats Exposed to 900 MHz Radiofrequency 2014.pdf, Auto-Induced Downlink Radiofrequency Electromagnetic Field Exposure at 3.5 GHz with Focusing Near the Head.pdf, The CB1R of mPFC is involved in anxiety-like behavior induced by 0.8:2.65 GHz dual-frequency electromagnetic radiation.pdf, Repeated Head Exposures to a 5G-3.5 GHz Signal Do Not Alter Behavior but Modify Intracortical Gene Expression in Adult Male Mice.pdf, The Effect of Proximity Sensor & Grip Sensor Use on Specific Absorption Rate (SAR) in Smartphones.pdf, Active matter as the underpinning agency for extraordinary sensitivity of biological membranes to electric fields _ PNAS.pdf, The Effect of 900-Megahertz Electromagnetic Field Exposure in the First and Middle Adolescent Period on the Spleen in Male Rats- A Biochemical and Histopathological Study.pdf, Long-term exposure to a continuous 900 MHz electromagnetic field disrupts cerebellar morphology in young adult male rats .pdf, Longtermexposuretoacontinuous900MHzel.pdf, Effect of the prenatal electromagnetic field exposure on cochlear nucleus neurons and oligodendrocytes in rats .pdf, Impressions of the chronic 900-MHz electromagnetic field in the prenatal period on Purkinje cells in male rat pup cerebella- is it worth mentioning.pdf, Adverse effects in lumbar spinal cord morphology and tissue biochemistry in Sprague Dawley male rats following exposure to a continuous 1-h a day 900-MHz electromagnetic field throughout adolescence 2016 .pdf, A histopathological and biochemical evaluation of oxidative injury in the sciatic nerves of male rats exposed to a continuous 900-megahertz electromagnetic field throughout all periods of adolescence.pdf, Alterations of thymic morphology and antioxidant biomarkers in 60-day-old male rats following exposure to a continuous 900 MHz electromagnetic field during adolescenc.pdf, Altered morphology and biochemistry of the female rat liver following 900 megahertz electromagnetic field exposure during mid to late adolescence.pdf, Biochemical and pathological changes in the male rat kidney and bladder following exposure to continuous 900-MHz electromagnetic field on postnatal days.pdf, Can prenatal exposure to a 900 MHz electromagnetic field affect the morphology of the spleen and thymus, and alter biomarkers of oxidative damage in 21-day-old male rats__ Biotechnic & Histochemistry_ Vol 90, No 7.pdf, Changes in pyramidal and granular neuron numbers in the rat hippocampus 7 days after exposure to a continuous 900-MHz electromagnetic field during early and mid-adolescence.pdf, Changes in testicular morphology and oxidative stress biomarkers in 60-day-old Sprague Dawley rats following exposure to continuous 900-MHz electromagnetic field for 1 h a day throughout adolescence.pdf, Chronic prenatal exposure to the 900 megahertz electromagnetic field induces pyramidal cell loss in the hippocampus of newborn rats - O Bas, E Odaci, H Mollaoglu, K Ucok, S Kaplan, 2009.pdf, Continuous 900-megahertz electromagnetic field applied in middle and late-adolescence causes qualitative and quantitative changes in the ovarian morphology, tissue and blood biochemistry of the rat,.pdf, Deleterious impacts of a 900-MHz electromagnetic field on hippocampal pyramidal

neurons of 8-week-old Sprague Dawley male rats.pdf, Disruption of the ovarian follicle reservoir of prepubertal rats following prenatal exposure to a continuous 900-MHz electromagnetic field 2016.pdf, Effects of 900-MHz electromagnetic fields exposure throughout middle:late adolescence on the kidney morphology and biochemistry of the female rat.pdf, Effects of long-term exposure to 900 megahertz electromagnetic field on heart morphology and biochemistry of male adolescent rats 2016.pdf, Effects of prenatal exposure to a 900 MHz electromagnetic field on 60-day-old rat testis and epididymal sperm quality 2016 .pdf, Exposure to a 900 MHz electromagnetic field for 1 hour a day over 30 days does change the histopathology and biochemistry of the rat testis_ International Journal of Radiation Biology_ Vol 91, No 7.pdf, Long-term exposure to a continuous 900 MHz electromagnetic field disrupts cerebellar morphology in young adult male rats.pdf, Maternal exposure to a continuous 900-MHz electromagnetic field provokes neuronal loss and pathological changes in cerebellum of 32-day-old female rat offspring 2016.pdf, Morphological and antioxidant impairments in the spinal cord of male offspring rats following exposure to a continuous 900 MHz electromagnetic field during early and mid-adolescence 2016 .pdf, Non-thermal effects of EMF upon the mammalian brain.pdf, Pathological effects of prenatal exposure to a 900 MHz electromagnetic field on the 21-day-old male rat kidney_ Biotechnic & Histochemistry_ Vol 90, No 2.pdf, Pernicious effects of long-term, continuous 900-MHz electromagnetic field throughout adolescence on hippocampus morphology, biochemistry and pyramidal neuron numbers in 60-day-old Sprague Dawley male rats 2016 .pdf, Pyramidal Cell Loss in the Cornu Ammonis of 32-day-old Female Rats Following Exposure to a 900 Megahertz Electromagnetic Field During Prenatal Days.pdf, Radiofrequency and Extremely Low-Frequency Electromagnetic Field Effects on the Blood-Brain Barrier_ Electromagnetic Biology and Medicine_ Vol 27, No 2.pdf, STRUCTURAL CHANGES OBSERVED IN MICE LIVER DUE TO CHRONIC EXPOSURE OF 1900-2200 MHZ RADIATIONS EMITTED FROM MOBILE PHONE.pdf, The Effect of 900-Megahertz Electromagnetic Field Exposure in the First and Middle Adolescent Period on the Spleen in Male Rats.pdf, The effect of prenatal exposure to 900-MHz electromagnetic field on the 21-old-day rat testicle - ScienceDirect.pdf, The Effects of Prenatal Exposure to a 900 Megahertz Electromagnetic Field on Hippocampus Morphology and Learning Behavior in Rat Pups.pdf, The effects of prenatal exposure to a 900-MHz electromagnetic field on the 21-day-old male rat heart_ Electromagnetic Biology and Medicine_ Vol 34, No 4.pdf, Heroux Biology EMFs.pdf, Biomedical Effects of EMF Russia 130 Years of Research .pdf, Nursing Textbook Wireless and Non-Ionizing EMF Pollution Environ Health in Nursing Dodd Scarato 2022.pdf, A Novel Method for Achieving Precision and Reproducibility in a 1.8 GHz Radiofrequency Exposure System That Modulates Intracellular ROS as a Function of Signal Amplitude in Human Cell Cultures 2025.pdf

Analysis of the Association of Mobile Phone Usage and Hearing Function in Young Adults 2025.pdf, Cell Phone Radiation Exposure Limits and Engineering Solutions ICBE-EMF .pdf, Effects of 1800 MHz and 2100 MHz mobile phone radiation on the blood-brain barrier of New Zealand rabbits .pdf, Evaluation of 900 and 1800 Mhz Radiofrequency Radiation Emitted from Mobile Phones on Pregnant Women.pdf, Exposure to Radiofrequency Induces Synaptic Dysfunction in Cortical Neurons Causing Learning and Memory Alteration in Early Postnatal Mice.pdf, Membrane potential and cancer progression.pdf, Radio Frequency Electromagnetic

Radiation(RF-EMR) Emitted from Mobile Phone and its Impact on Male Reproductive Health.pdf, Review Electromagnetic field and brain development.pdf, Risks to Health and Well-Being From RF Radiation Emitted by Cell Phones and Other Wireless Devices (1).pdf, The assumption of safety is being used to justify the rollout of 5G technologies copy (1).pdf, The CB1R of mPFC is involved in anxiety-like behavior induced by 0.8:2.65 GHz dual-frequency electromagnetic radiation.pdf, Wireless technologies, non-ionizing electromagnetic fields and children with Supplementals .pdf, Histopathological effects of mobile phone radiation exposure on the testes and sperm parameters A systematic literature review of animal studies 2024 copy.pdf, Hazardous effects of cell towers near homes and schools.pdf, A review of effects of electromagnetic fields on ageing and ageing dependent bioeffects of electromagnetic fields 2024 .pdf, Wireless Radiation and Health Congressional-Briefing-5-19-24-FINAL.pdf, 2.45 GHz Microwave Radiation Impairs Learning and Spatial Memory via Oxidative:Nitrosative Stress Induced p53 Dependent:Independent Hippocampal Apoptosis- Molecular Basis and Underlying Mechanism .pdf, Accumulative Effects of Multifrequency Microwave Exposure with 1.5 GHz and 2.8 GHz on the Structures and Functions of the Immune System.pdf, Beatrice-A-Golomb-Lecture-Pulsed RF from Smart Meters Health Efects .pdf, Cell Towers and Wireless Antenna Facilities at and Near Schools Risks and Liabilities Briefing 2024 (1).pdf, Biochemical effects of exposure to cell phone radiation electromagnetic field in mice.pdf, Effect of terahertz radiation on cells and cellular structures 2025.pdf, Evaluation of cognitive functions and EEG records in rats exposed to 2.45 GHz electromagnetic field.pdf, Impact of wireless radiation and cell towers on human health Inter Journal of Engineering .pdf, Metabolomic and gene networks approaches reveal the role of mitochondrial membrane proteins in response of human melanoma cells to THz radiation - ScienceDirect.pdf, Pathophysiology of microwave radiation- effect on rat brain Kesari Kumar and Behari .pdf, Possible effects of radiofrequency electromagnetic radiation on contextual fear conditioning, hippocampal perivascular space, apoptosis and adrenal gland microarchitecture in rats.pdf, Radiofrequency Electromagnetic Fields- evaluation of cancer hazards.pdf, Short-term exposure of 2.4 GHz electromagnetic radiation on cellular ROS generation and apoptosis in SH-SY5Y cell line and impact on developing chick embryo brain tissue.pdf, Status of the Neuroendocrine System in Animals Chronically Exposed to Electromagnetic Fields of 5G Mobile Network Base Stations.pdf, The biological effects of electromagnetic exposure on immune cells and potential mechanisms_ Electromagnetic Biology and Medicine_ Vol 41, No 1.pdf, The Impact of Proximity to CellPhone Tower Base Stations on Residential Property Prices in the City of Johannesburg South Africa.pdf, A critical appraisal of the WHO 2024 systematic review of the effects of RF-EMF exposure on tinnitus, migraine:headache, and non-specific symptoms.pdf, Effect of radiation emitted from mobile phone on innate immunity in mice_ Radiation Effects and Defects in Solids_ Vol 0, No 0 - Get Access.pdf, Electromagnetic Hypersensitivity (EHS) is a humanitarian crisis that requires an urgent response. copy.pdf, Electromagnetic Hypersensitivity (EHS) is a humanitarian crisis that requires an urgent response..pdf, Electrostatic pollination by butterfliesand moths.pdf, Literature review potential non-thermal molecular effects of external radiofrequency electromagnetic fields on cancer (1).pdf, Microwave Radiation Caused Dynamic Metabolic Fluctuations in the Mammalian Hippocampus copy.pdf, People Injured by Smartmeters MA 2024.pdf, Radiofrequency electromagnetic radiation-induced behavioral changes and their possible basis.pdf, The Electromagnetic Radiation Effect of Mobile Phone to

the Inflammation Cells in Gingival (Rattus Norvegicus) .pdf, The Environmental Impacto f Exposuret o Electromagnetic Fields EMF on Health.pdf, The Exposure to 2.45 GHz Electromagnetic Radiation Induced Different Cell Responses in Neuron-like Cells and Peripheral Blood Mononuclear Cells.pdf

Wildlife and wireless radiation briefing memo Manville 2024 .pdf, Far-Field Numerical Radio-Frequency Dosimetry of Insects Arno Thielens 2022.pdf, Effect of Exposure to 900 MHz GSM Mobile Phone Radiofrequency Radiation on Estrogen Receptor Methylation Status in Colon Cells of Male Sprague Dawley Rats - PubMed.pdf, Cell Tower Threat To Migratory and Endangered Birds .pdf, cell tower radiation and health Evaluation of oxidative stress and genetic instability among residents near mobile phone base stations in Germany.pdf, Cell Phone Radiation and Reproductive Health Kesari Text 12-24-24.pdf, The FCC must Prepare an Environmental Impact Statement For New Rules on Wireless Radiation Exposure (1).pdf, Panagopoulos - 2020 - UMTS - Caffeine - blood lymphocytes-GPB copy.pdf, Panagopoulos-Mob phone and gamma radiation HPBLs-2024 copy 2.pdf, Reduced Fertility and Increased Number of Birth Defects under Cell Phone Radiation- Documentation from a Pig Farm.pdf, Review on the impact of cell phone radiation effects on green plants - PubMed.pdf, Children and Health Effects of Screens Congress Abstract Book .pdf, Introduction from Preventing Regulatory Capture.pdf, Panagopoulos et al-IJRB-2010 copy.pdf, Temperature Distribution and Specific Absorption Rate inside a Child's Eyes from Mobile Phone .pdf, Steve Weller- 5G Safety -State of the art from scientific reviews and their findings.pdf, EHT Scarato Appeal RE FOIA Control Nos. 2023-000281 and 2023-000325_ FCC 2 mm Cell Phone Radiation SAR Tests December 28 2023 pdf.pdf, FCC Cell Phone Radiation Body SAR Tests Released Under FOIA 2mm SAR Tests Found High Radiation .pdf, Microwave Emissions From Cell Phones Exceed Safety Limits in Europe and the US When Touching the Body Gandhi 2019.pdf, Cellphone-lawsuit-August-2019-Apple v Cohen SAR levels Chicago tribune 2.pdf, FOIA Control No. 2023-000281 and 000325 Theodora Scarato Response Letter_092923.pdf, Press Release Concealed FCC Cell Phone Radiation Tests Show Human Exposure Limits Were Exceeded.pdf, EHT Letter FOIA Control No. 2023-000281 and 000325 Theodora Scarato Response Letter_092923 copy.pdf, TR Daily EHT Blasts FCC Timing (FCC 2 mm cell phone radiation SAR test) .pdf, PMST SAR Report - Mar 22 2017.pdf, Attestation Letter - Feb 16 2017.pdf, Cell Phone RF Exposure Compliance Test Report - Dec 18 2019 (release to Roe, Mahr has copy).pdf, Full Set of EHT FOIA RE Cell phone radiation testing (1).pdf, 2025-EPA-01333 EPA to Scarato No EMF Research November 2024r (2).pdf, Biophysical mechanism of animal magnetoreception, orientation and navigation .pdf, Exposure to Radiofrequency Electromagnetic Fields Enhances Melanin Synthesis by Activating the P53 Signaling Pathway in Mel-Ab Melanocytes..pdf, Role of Mitochondria in the Oxidative Stress Induced by Electromagnetic Fields- Focus on Reproductive Systems.pdf, The histological investigation of the effects of electromagnetic radiation on rat ovaries.pdf, The Transcriptomic Response of Cells of the Thermophilic Bacterium Geobacillus icigianus to Terahertz Irradiation.pdf, Verification of radical pair mechanism predictions for weak magnetic field effects on superoxide in planarians.pdf, Santa Fe New Mexican Report says wireless radiation may harm wildlife.pdf, Wildlife and plants Low level effects- Ecosystem approach Levitt et al 2022.pdf, Wildlife, Wireless, EMF Bio-Effects and Science .pdf, EMF flora fauna review part 1

Levitt Lai Manville 10.1515_reveh-2021-0026.pdf, RF bio effects exposure guidelines intensity duration modulation Lai Levitt 2022.pdf, Wildlife and plants Low level effects- Ecosystem approach Levitt et al 2022 copy.pdf, Levitt Biological effects from exposure to electromagnetic radiation emitted by cell tower base stations and other antenna arrays lai levitt .pdf, EMF Effects Wildlife 3 PT Review Levitt Manville Lai.pdf, EMF and Wildlife Part 2 + supplements Levitt Lai Manville 2021.pdf, EMF Wildlife Review Part 1 Levitt :Lai : Manville .pdf, Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation Balmori 2015.pdf, Balmori 2015 Anthropogenic radiofrequency electromagnetic fields as an emerging threat to wildlife orientation.pdf, Balmori Cell Tower Radiation Research Review 2022.pdf, Dr. Alfonso Balmori Declaration White Storks and Birds .pdf, Balmori Radio-tracking systems emit pulsed waves that could affect the health and alter the orientation of animals .pdf, Electromagnetic radiation as an emerging driver factor for the declineof insects Balmori copy 2.pdf, Statementsby Alfonso Balmori .pdf, Statements to the FDA by Alfonso Balmori, BSc, Paul.pdf, Carlberg & Hardell 2017.pdf, 5G Case Report on Microwave Syndrome Hardell Nilsson 1-10-23.pdf, High radiofrequency radiation at Stockholm Old Town- An exposimeter study including the Royal Castle, Supreme Court, three major squares and the Swedish Parliament Hardell et al Mol Clin Oncol 2017 copy 2.pdf, Hardell- Comments on the US National Toxicology Program technical reports on toxicology and carcinogenesis study in rats exposed to whole-body radiofrequency radiation at 900 MHz and in mice exposed to whole-body radiofrequency radiation at 1,900 MHz.pdf, Thermal and non-thermal health effects of low intensity non-ionizing radiation- An international perspective, perspective Belpomme Hardell Carpenter 2018.pdf, Wireless headsets docs patients Sage Hardell 2018.pdf, World Health Organization, radiofrequency radiation and health - a hard nut to crack (Review) Lennart Hardell .pdf, Hardell, Nilsson . A Critical Analysis of the World Health Organization (WHO) Systematic Review 2024 on Radiofrequency Radiation Exposure and Cancer Risks 2025.pdf, Hardell Studies Compilation Small Cells .pdf, Hardell Montgomery County Public School Letter from Dr. Hardell.pdf, Hardell et al Oncology Letters 2018 Radiofrequency radiation from nearby base stations gives high levels in an apartment in Stockholm, Sweden- A case report copy.pdf, Hardell Health Council of the Netherlands and evaluation of the fifth generation, 5G, for wireless communication and cancer risks .pdf, Case Report- A 52-Year Healthy Woman Developed Severe Microwave Syndrome Shortly After Installation of a 5G Base Station Close to Her Apartment.pdf, Cell Phones Meet criteria for carcinogen CarlbergHardellBioMedResInt2017 copy.pdf, Development of the Microwave Syndrome in Two Men Shortly after Installation of 5G on the Roof above their Office.pdf, Hardell Appeals that matter or not on a moratorium on the deployment of the fifth generation, 5G,.pdf, Health risks from radiofrequency radiation, including 5G, should be assessed by experts with no conflicts of interest.pdf

Hardell, Carlberg & Gee 2012.pdf, Risks to Health and Well-Being From Radio-Frequency Radiation Emitted by Cell Phones and Other Wireless Devices davis copy 3.pdf, Summary of seven Swedish case reports on the microwave syndrome associated with 5G radiofrequency radiation .pdf, Hardell Moskowitz MOBI-Kids Rev Env Health 2022.pdf, Hardell Nilsson 5G Microwave syndrome Annals of Case Reports 2023.pdf, Tesla Exempt Solicitation Wireless Radiation 2024.pdf, Google Wireless Radiation Health Exempt Solicitation 2024.pdf,

EHT-et-al.-v.-FCC-Factsheet-EHTRUST.org-3.pdf, 20-1025-NRDC-amicus-brief EHT et al v FCC.pdf, 20-1025-Amicus-Brief-Joe-Sandri.pdf, Brief-of-Amicus-Curiae-Building-Biology-Institute.pdf, 20-1025-Kleiber-Amicus-Brief EHT et al v FCC.pdf, EHT et al v FCC Petitioners-Final-Joint-Opening-Brief.pdf, EHT et al v FCC Petitioners-Final-Joint-Reply-Brief.pdf, FDA Report by Theodora Scarato Cell Phones and Radiofrequency Radiation Health Effects .pdf

2019 Belyaev Regularities Health Risks Non-Thermal Microwaves of Mobile Communication-2.pdf, adverse-health-effects-of-5g-mobile-networking-technology-under-real-life-conditions.pdf, Carpenter Bandara Planetary electromagnetic pollution- it is time to assess its impact copy 2.pdf, 5G Wireless Future-SCCMA Santa Clara Medical Association copy.pdf, Lin The Significance of Primary Tumors in the NTP Study of Chronic Rat Exposure to Cell Phone Radiation.pdf, Evaluation of Genotoxicity of Cell Phone Radiofrequency Radiation in Male and f the Genot d Female no toxicity e Rats and y Ce d Mice ell Ra e Following g Subchronic ncy c Exposure Poster PDF .pdf, How Big Wireless Made Us Think That Cell phones were safe A Special Investigation The Nation.pdf, American Academy of Pediatrics Letters to FCC and Congress , Dr. Birnbaum , Dr. Paulson and AAP on cell towers .pdf, Dr. Magda Havas- Letter on WiFi in Public Places .pdf, Dr Andrew Goldsworthy Autism and EMFS .pdf, Australian Physicians Oppose Smartmeters .pdf, Dr. De Kun Li Testimony on Smartmeters and FCC limits .pdf, 5G Abstracts Millimeter waves .pdf, Hugh Scully lettre Toronto.pdf, Physiciand-For-Safe-Technology-A-Letter-Governor-Brown-Short-mailed-PDF9_19_17-.pdf, Italy-scientific-appeal-on-wireless-radiation-limits.pdf, Letters to from FDA, NCI, FCC, New Hampshire Scarato.pdf, WHO Unanswered Letters Van Deventer .pdf, Wireless SilentSpring Santa Clara Medical Association Oct 2 2018.pdf, Wifi In Schools Santa Clara Medical Association Article.pdf, Child Absorption of RF from Tablet Study copy.pdf, Wi-Fi in School Briefing .pdf, Clegg, Building and Environment copy.pdf, MD State Council on Children Environmental Health Recommendation Wi-Fi in School .pdf, RF Exposure Due to Mobile Devices Operated Close to the Human Body 2019 EuMW copy 2.pdf, On-the-Clear-Evidence-of-the-Risks-to-Children-from-Smartphone-and-WiFi-Radio-Frequency-Radiation-Final-2019 copy.pdf, LETTER CEHPAC to FCC request update human environmental health impacts 190501 FINAL 190609.pdf, Miller et al (1). Cancer epidemiology update copy 3.pdf, MarthaHerberttoMCPS2015.pdf, Shallow Minds SCCMA Article copy.pdf, 2.45 GHz Microwave Radiation Impairs Learning and Spatial Memory via Oxidative:Nitrosative Stress Induced p53 Dependent:Independent Hippocampal Apoptosis- Molecular Basis and Underlying Mechanism .pdf, Effects of Heat and WiFi (2.4 GHz) Exposure on Rat Cardiovascular System.pdf, RAPD Profiling, DNA Fragmentation, and Histomorphometric Examination in Brains of Wistar Rats Exposed to Indoor 2.5 Ghz Wi-Fi Devices Radiation.pdf, The Effect of Electromagnetic Radiation Transmitted from Routers on Antibiotic Susceptibility of Bacterial Pathogens.pdf, Wi-Fi medical studies.pdf, WIFI threat Martin Pall 2018 Environmental Research .pdf, Avendano et al. 2012.pdf, lerchl 2015.pdf, nonionizing radiation international perspective Belpomme Hardell Carpenter 2018.pdf, Specific-Absorption-Rate-Evaluation-for-Passengers-Using-Wireless-Communication-Devices-Inside-Vehicles-With-Different-Handedness-Passenger-Counts-and-Seating-Locations copy.pdf,

Yakymenko et al 2016 copy.pdf, ClaudioFernandezVirtualReality2018.pdf, Trigger of a migraine headache among Thai adolescents smartphone users- a time series study.pdf, Analyzing the SAR in Human Head Tissues under Different Exposure Scenarios.pdf, Temperature Distribution and Specific Absorption Rate inside a Child's Eyes from Mobile Phone .pdf, Yury_Grigoriev_2010_IElectromagnetic fields and the public- EMF standards and estimation of risk.pdf, Brazil Mast Study 2012.pdf, Cancer_risks_in_the_Druze_Isifya_Village.pdf, 31 - Base Stations and Human Hormone Profiles.pdf

Evidence of Health Effects of Electromagnetic Radiation, To the Australian Senate Inquiry into Electromagnetic Radiation.pdf, Actual or potential effects of ELF and RF:MW radiation on enhancing violence and homicide, and accelerating aging of human, animal orplant cells.- 2002.pdf, Evidence of Neurological effects of Electromagnetic Radiation- Implications for degenerative disease and brain tumour from residential, occupational, cell site and cell phone exposures.- 2002.pdf, Reproductive effects from EMF:EMR exposure .pdf, Epidemiological Principles for ELF and EMR Studies .pdf, Motorola Funded Counter Research on Microwave DNA Damage.pdf, Effects of 4G EMF on thyroid hormone dystfuntion and behavioral changes in adolescent male mice.pdf, Relationship between radiofrequencyelectromagnetic radiation from cellular phones and brain tumor- meta-analyses using various proxies for RF-EMR exposure-outcome assessment.pdf, Impact of low frequency ELF EMF on skeleton of mice by Morabito.pdf, A review on the consequences of molecular and genomic alterations following exposure to electromagnetic fields- Remodeling of neuronal network and cognitive changes.pdf, ASSESSING THE RISK OF NEGATIVE EFFECTS PRODUCED BY ELECTROMAGNETIC FIELDS OF CELLULAR COMMUNICATION ON THE CENTRAL NERVOUS SYSTEM OF CHILDREN AND ADOLESCENTS (REVIEW). PART 2. INDICATORS OF COGNITIVE PROCESSES 2024-3-15.pdf, Does Radiofrequency Radiation FromMobile Phones Affect the Formationof Parotid Gland Malignancy? AnExperimental Study ozergin-coskun-et-al-2024-formation-of-parotid-gland copy.pdf, Effects of 5G radiofrequency electromagnetic radiation on indicators of vitality and DNA integrity of in vitro exposed boar semen - ScienceDirect 2024.pdf, Effects of Head only exposure to 900 MHz GSM EMF in rats changes in neuronal activity Boimedicines 2024 by Bontempi .pdf, ELECTROMAGNETIC FIELD EXPOSURE IN THE PUBLIC SPACE OF THE SLOVAKIAN CITY.pdf, Epigenetic modifcation of gene expression in cancer cells by terahertz demethylation wireless health risk.pdf, International Journal of Cell Biology - 2024 - Alharbi - The Effect of Exposure to Mobile Phones on Electrical Cardiac.pdf, Wi-Fi exposure to anmals Changes in the content of dopamine, serotonin, their precursors and derivatives in the prefrontal cortex of young male rats under chronic exposure to a low-intensity electromagnetic field.pdf, Nursing Textbook Wireless and Non-Ionizing EMF Pollution Environ Health in Nursing Dodd Scarato 2022.pdf, Evaluation of 900 and 1800 Mhz Radiofrequency Radiation Emitted from Mobile Phones on Pregnant Women.pdf, Cell Phone Radiation Exposure Limits and Engineering Solutions ICBE-EMF .pdf, Human Skin as Arrays of Helical Antennas in the Millimeter and Submillimeter Wave Range 2008 .pdf, 5G Stateoftheart ReviewResponsetoKaripidis.pdf, The electromagnetic response of human skin in the millimetre and submillimetre wave range.pdf, 2019_Malka_Devra Lessons learned from the application of machine learning to studies on plant response to radio-frequency.pdf, Exposure to RF EMF

From Array Antennas in 5G Mobile Communication Equipment Skin Heating.pdf, millimeter wave bio effects Gandhi 1986.pdf, European_Journal_on_Oncology_December_2015. International_EMF_Scientist_Appeal copy.pdf, Exposure of Insects to RadioFrequency Electromagnetic Fields from 2 to 120GHz 5g .pdf, Miller et al (1). Cancer epidemiology update copy 2.pdf, 5G public health environmental implications Cindy Russell 2018 copy.pdf, The Modeling of the Absorbance of Sub-THz Radiation by Human Skin feldman, ishai.pdf, Impact of radiofrequency radiation on DNA damage and antioxidants in peripheral blood lymphocytes of humans residing in the vicinity of mobile phone.pdf, The association of widely used electromagnetic waves exposure and pregnancy and birth outcomes in Yazd women- a cohort study.pdf, Environmental Research 2023 Problems in evaluating the health impacts of radio frequency radiation Ben Ishai Birnbaum.pdf, early research standard setting Behavioral and thermal effects of microwave radiation at resonant and nonresonant wavelengths.pdf, Five Research Papers on Wi-Fi, EMF in Buildings Compilation.pdf, Secret Ties to Industry and Conflicting Interests in Cancer Research.pdf, Sponsor Influences on quality and independence of health research NAIS 2023.pdf, Health effects of wireless and non ionizing SCIENTIFIC STUDIES 2021.pdf, health effects of wireless radiation SCIENTIFIC STUDIES 2019.pdf, Health effects of wireless radiation SCIENTIFIC STUDIES 2020.pdf, health effects of wireless radiation SCIENTIFIC STUDIES 2022.pdf, Health effects of wireless radiation SCIENTIFIC STUDIES 2023.pdf, Health effects of wireless radiationSCIENTIFIC STUDIES 2019 copy.pdf, S.2855 Scientific Research on Environmental Impacts of Wireless Networks EHT 10-25-23-2.pdf, A New Look at Three Potential Mechanisms Proposed for the Carcinogenesis of 5G Radiation 1.pdf, Hazardous Effects of EM Radiation from Siting Cell Towers Mobile Phone Masts Close to Residential Houses and Schools.pdf, NTIA National Spectrum Strategy Environmental Health Trust Scientific Comment on the Health and Environmental Effects of Wireless Radiation 2024 FINAL .pdf, Microwaves from Mobile Phones Inhibit 53BP1 Focus Formation in Human Stem Cells More Strongly Than in Differentiated Cells- Possible Mechanistic Link to Cancer Risk.pdf